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FROM THE APPENDIX

TO THE

WASHINGTON ASTRONOMICAL OBSERVATIONS

FOR 1847.

OBSERVATIONS

ON

SOLAR SPOTS,

MADE

AT THE OBSERVATORY OF GEORGETOWN COLLEGE,

SEP. 20 TO NOV. 6, 1850.

BY

PROF. BENEDICT SESTINI, S.J.

FORTY-FOUR DIAGRAMS.

WASHINGTON:
C. ALEXANDER, PRINTER,
1853.

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SUN SPOTS.

Letter from Professor Sestini to Lieut. Maury, communicating observations on Solar Spots, made by him at the Georgetown College, Sept. 30, to Nov. 6, 1850.

GEORGETOWN COLLEGE OBSERVATORY, D. C.
November 18, 1850.

DEAR SIR:—Soon after Professor Curley received your kind letter, I endeavoured to fulfil your desire with regard to the series of changes of some most remarkable spots. With the present letter I undertake to satisfy the other request. And were you not acquainted with my native tongue, and did I not know your kindness, I should beg your indulgence for the imperfection of style, which you will find in this note. Therefore without going any farther, I will begin as well as I can the requisite account of the observations.

And first, you are already acquainted that the Directer of this observatory, Professor Curley, suggested to me the idea of undertaking a series of observations on solar spots about two years ago; and that I made at that time some attempt to take drawings from the image of the Sun received on white paper. Which method, though perhaps in some respects preferable, yet in others is far inferior to that of drawings made by looking directly at the Sun. In the present series I adopted the last method before trying that of receiving the Sun's image on photographic paper, recommended to F. Curley by Professor Henry. Among the reasons that I did prefer a method more familiar to me, were the encouragement I received from you, and a sense of gratitude, urging me to finish as soon as possible that series of observations, for which you offered room in the next volume of your annual publications. And it is indeed to me a real satisfaction also to re-assume these little labors to which I feel inclined, and which I found proposed by Sir John Hershel, in his work on the observations made at the Cape of Good Hope, as a kind of research, worthy of being taken into consideration, although for a long time neglected. But my present collection, though the first part contains a succession of 29 days without interruption, does not furnish such numerous facts, from which could be derived satisfactory consequences. However, besides a little journal which I kept, and in which will be found some remarks respecting the observations of each day, I will not omit here to point out some facts, which may deserve peculiar attention. And first, that one which seems to oppose the opinion of the spots being produced by openings or whirls formed in the fluid matter, which covers the dark nucleus of the Sun. Among the arguments alleged by the patrons of this opinion, there is the form of the spots when at the edge of the solar disk, compared with that of the same spot near the centre. When, they say, any spot is about to disappear behind the Sun's western limb, the eastern portion of the umbra

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first contracts in its breadth, and then vanishes; the nucleus also gradually contracts and vanishes, while the western portion of the umbra still remains visible. When a spot comes into view on the Sun's eastern limb, the eastern portion of the umbra first becomes visible, then the dark nucleus, and then the western part of the umbra makes its appearance. And I also saw the variations now described in some spots; in one of the small spots environed by vivid faculæ, which begins to appear on the 27th of September, and in another which came into view the 14th of October, and chiefly in one, which was visible for the first time on the 17th of October. It is still said that Dr. Wollaston and Lalande maintained the phenomenon not to be universal, and Lalande mentioned three observations of his own, and four observations by Cassini and De la Hire, in which the umbra did not vanish. And among my observations there are some similar cases, which before I speak of, I will remark that the want of the umbra in some parts about the dark nucleus is sometimes a real one. Observe the eastern spot of the 12th of October, and the same spot on the 1st of November; besides several other deficiencies which in many other cases may be easily observed. But there are spots, which at the edge of the disk, as well as at any other point of their visible track, are surrounded by uninterrupted umbra. Mark for example, that large spot which on the 19th of September was near the centre of the disk, and which, except the lateral contraction which depends on its oblique situation, continues to appear encircled by the umbra till its last appearence; see also that which enters the visible disk on the 20th of September, the very same one that is so variable during its course, especially in its extensive umbra unequal and frequently sparkling with brilliant points, and as difficult to be described as it was beautiful to behold. The nucleus moreover does not disappear before the last visible umbra, but in several cases continues to be seen to the very edge; and the spots which on the 28th, 29th and 30th of September, and those which on the 22d and 23d of October, are almost touching the western limb, and those also which came into view on the 2d, 3d and 11th of October, are as many confirmations of the fact. But the spot which more than any other appears to oppose the same opinion, is that visible for the first time on the 27th of September, the umbra of which instead of being visible towards the eastern side is visible on the opposite side alone, and the nucleus is perfectly visible. The succeeding days, the umbra is visible on both sides, although very changeable till the 6th of October; on the remaining days, 7th, 8th and 9th, it preserves a more invariable form, and constantly surrounds the nucleus visible to the edge. A diagram of the Sun, in which all the variations of this spot are seen at a glance, exhibits also to view its track on the solar disk. It should be called to mind also, that some authors use the very same umbra against the opinion of the spots being produced by depression; because, when for instance the spot is on the centre of the disk, the conical form of the holes necessarily contains a larger surface of the luminous fluid than that which is apparently visible between the nucleus and the margin of the umbra, and consequently they say, we would rather see a ring of light about the nucleus brighter than that of the Sun. This opposition does not evidently attack Sir William Herschel's view, who considers indeed the luminous strata of the atmosphere to be far above the level of the solid body, but sustained by a transparent elastic medium curving at some considerable lower level; a cloudy stratum which, being strongly illuminated from above, reflects a great portion of the light and forms the penumbra. Yet there remains still the objection of the nucleus visible at the edge, though at the

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bottom of a profound hole, as also that of the luminous spots sometimes enclosed within the penumbra. But similar and perhaps stronger objections may be opposed against other opinions, and, as I have said already, the number of my own observations do not as yet afford that evidence which can plausibly induce to prefer one explanation to another. At any rate presenting to the public a copious series of observations, it might happen that others may discover that which I am unable to find myself. I shall not omit however to remark that, supposing the solar spots not to be depressed beneath the luminous surface of the Sun, since they appear so different from the remaining igneous and probably fluid matter, the first conclusion, which presents itself, is that they are masses of dark matter and like floating islands on a fiery ocean. Galileo, Kepler, Bulliand, Hevelius and Scheiner also, although formerly of a different opinion, had nearly the same idea. De la Hire may be reckoned in the same number, and it will not be here useless to quote a few words on this subject from De Lalande's astronomy. Galileo, he says, thought the solar spots to be nothing else but a kind of smoke or clouds of foam, which gathers on the tops of an ocean of fluid matter. Hevelius is of the same opinion. But De Lalande does not agree with such an explanation, and he opposes to it the regularity of motion of the spots over the solar disk, the reappearance of the spots on the same place and the effect of the centrifugal force arising from the rotation of the Sun about its axis. And on account of such reasons, perhaps he does not exactly agree either with De la Hire's, although he finds De la Hire's opinion much more probable; who thinks that the solar spots are eminences of solid masses floating on the fluid matter of the Sun's surface; yet he adds, that it may be that such opaque spots are the very same body of the Sun commonly covered with the fiery fluid, and which occasionally shows some of its eminences on account of the motion of the same fluid:—and in this manner he give his reasons of several phenomena, and especially of the umbra, which should be the same opaque body only covered by a thin luminous surface. But in this case it seems that the umbra would diminish by degrees, and insensibly disappear at the farthest distance from the nucleus, which frequently is not the case. Nay, on the contrary the umbra is commonly fainter near the nucleus than at the edge of the margin, where it appears like sea-weed cast on the shores of the ocean, and forming sometimes at that outer circumference a kind of bead-work, as may be seen on the larger eastern spot of the 30th of September and in some other instances. I should observe here also that the same outer circumference is neither always quite curvilinear, and as I have found asserted, without any angle or sharp projection, nor uniform in the depth of the color. Which things may be easily seen in the series added at the end of the daily drawings to show the changes of some most remarkable clusters. With regard to the centrifugal force, on account of which floating masses would be confined within certain limits about the equatorial regions, this effect would rather confirm than oppose the opinion. For it is a known fact, that the spots very seldom are seen beyond a zone bisected by the equator, and about 60° in breadth; an observation made since the discovery of the spots; because Scheiner, to whom several authors attribute the first discovery of them, and who certainly was the first to publish the discovery, and more than any other observed them from the year 1618, to the year 1627—says that the whole breadth of the zone on which the spots are visible, does not exceed 30° on both sides of the equator; although in very rare cases some small spots are seen a little beyond the limits of that zone.

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After all this in the hypothesis of the solar spots being floating matter, should I be permitted to venture my opinion, I should be inclined to believe that the cause producing the nucleus of them, is the very same which produces the umbra, with the difference that the nucleus is formed by a greater accumulation of particles, the umbra by the same particles diffused over a larger space about the nucleus. In this manner we should not find it difficult to conceive either the different degrees of darkness of the umbra as depending on the greater or less diffusion of the particles, or the brighter spots inclosed in the same umbra, or the perpetual changes to which such light matter, agitated by the igneous fluid, and more or less heaped in different parts, and even sometimes so much accumulated as to form a dark colour like that of the nucleus itself, ought to be subject. Nay I would not find a great difficulty in imagining some nuclei formed by degrees through a similar accumulation. And here perhaps, some specimens of the observations may opportunely be noticed. And first, in the series* of the changes of the spot or cluster from the 20th of September to the first of October, the eastern umbra of the multiple nucleus, increasing between the 22d and 23d both in size and depth, on the 24th and 25th appears sprinkled with black points, which on the 26th are melted away; analogous variations may be seen on the following days. In the next series* of the changes of the cluster visible from the 11th to the 23d of October, the inferior umbra of the large spot formed between the 19th and 20th, being on the 21st detached from the broken nucleus, appears more contracted and overspread with several minute black spots, which become the nucleus visible the succeeding day. The last series* of the changes of another cluster from the 28th of October to the 4th of November, presents transformations of this kind. Among the others, we remark that of the bead which, on the 28th, terminates the umbra of a nucleus, and the following day seems to be united to form a short line. Similar compositions and decompositions are to be remarked the following days. Let us finally give once more a glance at the diagram† showing the path of a spot. We see the western umbra contracted between the 30th of September and the 1st of October—nay, almost reduced to a nucleus, which between the 1st and 2d again disappears and nearly reassumes the same form of a more extended umbra. Another phenomenon, observed when the spots begin to diminish, is, that the outline of the nucleus seems to dissolve and mingle with the umbra, until the whole nucleus becomes a mere umbra. I did not till now witness such a process, except partly with regard to the spot, which on the 2d of October is very near the centre of the disk, and on the succeeding days, 3d and 4th, diminishes, and on the 5th disappears. But it may be remarked that in the case of the nuclei sometimes formed and dissolved in the manner described, we cannot suppose great consistency in them. And indeed they have the appearance of being masses of a very friable description, being often observed to have a single nucleus broken in different parts; there are several examples of this kind, which may be seen in the present series of observations. It is reported that Dr. Long, once examining the Sun's image, saw a spot divide itself into two spots; and Dr. Wollaston saw a spot burst in pieces, when he was observing it, like a piece of ice, which thrown upon a frozen pond, breaks in pieces, and slides in various directions. With regard to the possibility of the different

* Diagram 44. † Diagram 43.

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degrees of darkness produced by the greater or less accumulation of the same substance, I should remark that this is the very effect produced by India ink, when used on white paper to represent the solar spots. The black nucleus as well as the surrounding umbra is produced by the same solution of that ink, only different in the degrees of density or repeatedly expanded in some places, to obtain the greater or less depth of color.

Now, before I give an extract from the Journal intended to explain those things, which may deserve to be better noticed than by the drawings alone, I shall make a few remarks with respect to the whole series of observations. First, then, the instrument used was a Pixii telescope, 4 feet with a 3 inches object-glass and astronomical English eye-piece of a power of 40; not a great power certainly, but to be preferred, I think, to many greater on account of the singularly distinct view which it gives of the spots, especially of the umbra. And having made some comparisons with the telescope of our equatorial instrument and with that excellent one of the transit instrument, I did not discover anything remarkable not already observed with the smaller telescope. To determine the positions of the spots on the solar disk, I placed in the diagram of the eye-piece, 11 silk fibres parallel to each other, and crossing an equal number of others vertical to them, and all together making a square divided into 100 small squares. With such an artifice, I can fix with sufficient accuracy the centre of some spots, and mark them on the circle representing the solar disk, before I commence the drawings. I have said with sufficient accuracy, because my object not being that of determining the track of the spots, it is enough to have each day the approximate position of them with reference to the circumference of the circle on which they are to be described.

When I commenced this series of observations, I had some idea of describing the faculæ as well as the spots which, I thought, was not a very difficult thing to do, making the drawings on yellow paper, for instance, and using white color for the faculæ. But the difficulty would have been found in engraving them, and though lithographic stones may be prepared in such a manner as to give the white and black colors; there is but little confidence to be put in lithographic printings for such purpose, because they seldom are clear from spots, than which nothing is worse in this kind of drawings. Again, since the drawings of the spots require a good deal of time, (though I did not give up the idea of pursuing the faculæ also,) I thought it to be better at first to devote my chief attention to them, and reserve for time of greater leisure some peculiar investigation on faculæ, whose drawings I perceived were not so easy to be made on account of the difficulty of ascertaining their outlines. Yet I did not entirely omit to remark something about them also, and some shadings are frequently to be seen in the drawings, commonly near the limbs or even about the umbras of the spots, encircling with their outlines white spaces, intended to show the places of the faculæ. These faculæ, as it is known, are usually visible near the limb; but in the clearest days the whole disk of the sun appears as if it were covered with them; that is, with brighter points, spots, lines or streams according to their appearance. It should be observed, moreover, that with regard to the spots coming into view in those places in which faculæ have been seen before, some cases seem to confirm it. That row of spots or clusters for example, of the 21st and following days of September, on the 19th were small and environed by faculæ; but the faculæ did not vanish when other spots began to appear, because when on the 27th and 28th the same row reached

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the western limb, it appeared surrounded by brilliant faculæ, and on the 14th and 15th of October, when the same spots were visible again on the eastern side, though remarkably diminished, still they appeared encircled by faculæ. Other similar facts are marked on the drawings. With regard to the reappearance of the spots at the eastern limb on the place of that which disappeared between the 1st and 2d of October there were seen on the 15th and 16th some small points, but the others, which ought to have come into view from time to time, appeared to have vanished. But let us now come to the Journal:—

1850. JOURNAL.

September 19th. Some of the spots have faculæ.

20th. A new spot appears on the east side on account of the revolution of the Sun, and two new spots are formed—one disappears at the northwest quarter—the small cluster lying north of the round spot, diminishes both in number and size;—the faculæ appear as on the preceding day.

21st. New spots continue to be formed, and clusters—faculæ appear as on the other days.

22d. The small northwestern spot has wholly disappeared, and faculæ only remain in its place—some changes in the other spots and clusters.

23d. The same changes continue, especially on the largest spot;—three small spots south of the large western vanished;—the spot on the southeast quarter, remarkably enlarged.

24th. Some spots are still getting larger, and the most westerly of the clusters has increased in size and number of individual nuclei;—the number of all the nuclei is more than 60.

25th. The north-western spot disappears, and some faculæ are visible near its place; some small spots begin to be visible towards the eastern limb;—a bright spot is enclosed in the umbra of the southern cluster;—the number of the nuclei surpasses 70.

26th. The small spot that lies south of the western clusters has vanished;—two new spots on account of the revolution appear on the southeastern quarter, surrounded by faculæ; the number of the nuclei is diminished.

27th. Two new spots appear, formed north of the western cluster;—another comes into view on the southeastern edge.

28th. A small cluster, that lies between two spots on the N. W. appears as one spot—faculæ as usual.

29th. Two N. W. spots have disappeared beyond the sun's edge.

30th. The small spots that were visible on the preceding day, near the middle of the Sun, have vanished.

October 1st. The western spot which began to diminish the preceding days, still diminishes.

2d. Two spots come into view on the eastern edge, and a small cluster which on the 30th had disappeared, appears again.

3d. New small spots brought to view by the rotation;—the nucleus of the larger spot is divided into two.

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October 4th. Some small spots disappear by the Sun's rotation; some others diminish in size.

5th. Another small spot appears on the southeastern part.

6th. The same spot is no more visible.

7th. Some spots disappear by the rotation;—faculæ.

8th. Some new spots appear by the sun's revolution.

9th. New spots are formed on the southwestern quarter.

10th. The same spots increase, but one near them vanishes.

11th. The eastern small has cluster vanished;—a new spot comes into view.

12th. The western spots diminish; the eastern becomes a cluster.

13th. New small spots appear near the middle of the sun's disk;—another comes into view;—the cluster increases.

14th. The cluster still increases;—a new spot comes into view.

15th. The cluster increases still more, and contains more than 20 nuclei; new spots appear by the rotation in that place in which a larger spot appeared on the 20th of September.

16th. Nothing remarkable.

17th. Some new spots not seen at the commencement of the revolution come into view.

18th. The sun was not visible during this day.

19th. A new cluster comes into view;—the cluster of the preceding days shows some remarkable changes.

20th. The triple nucleus of the preceding day near the northwestern edge has the same parts separated farther apart from each other; some other nuclei of the same cluster seem to have united into one large spot.

21st. 22d. No remarkable changes.

23d. The nucleus of the large spot of the cluster, exactly on the northwestern limb, is perfectly visible.

24th. 25th. 26th. 27th. Sun covered.

28th. A beautiful cluster, containing at least 30 nuclei, on the southeastern quarter, where also a new spot appears.

29th. Some spots disappeared by the rotation;—the cluster presents several changes, increases in size, and there may be reckoned 46 different nuclei.

30th. The cluster still changes and increases; it contains about the same number of nuclei.

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October 31st. New changes of the cluster;—it contains about 40 nuclei;—the next spot to the cluster appears environed by small nuclei, about 20 in number.

November 1st. The cluster, besides other changes, appears to divide itself into two parts; it is environed by a bright margin of faculæ.

2d. The division of the cluster increases; other changes.

3d. New changes on the large cluster;—the little nuclei about the next spot are getting larger, forming a new cluster.

4th. The larger cluster approaches the edge;—the following cluster diminishes again.

5th. The sun was visible for a short time and observed;—presented the larger cluster almost entirely passed beyond the visible disk;—the small one vanished.

6th. The solar disk appears for the first time during the present series of observations without spots.

And this is the whole which I intended to place before the drawings which I sent you. Please to accept it, if not as a labor deserving consideration, at least as a mark of my most sincere esteem.

Yours, respectfully,

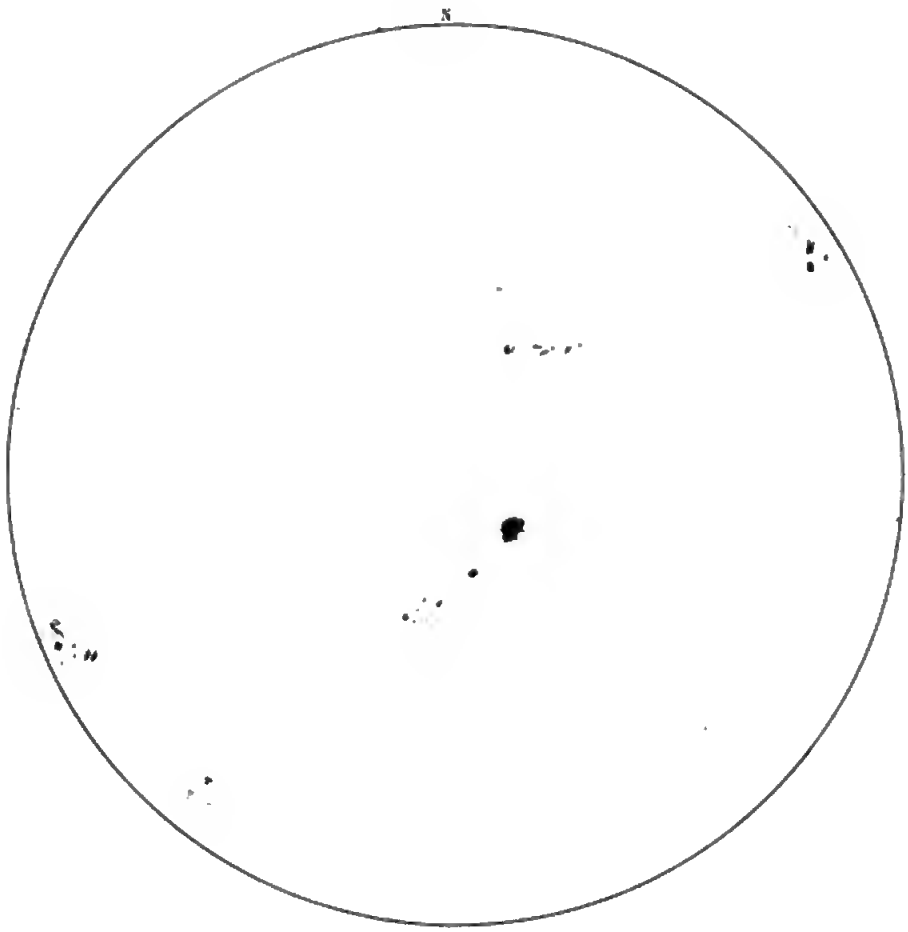
BENEDICT SESTINI.

Lieut. M. F. Maury,

National Observatory.

MAG 2005519

North Limb



Sept. 19th 1850

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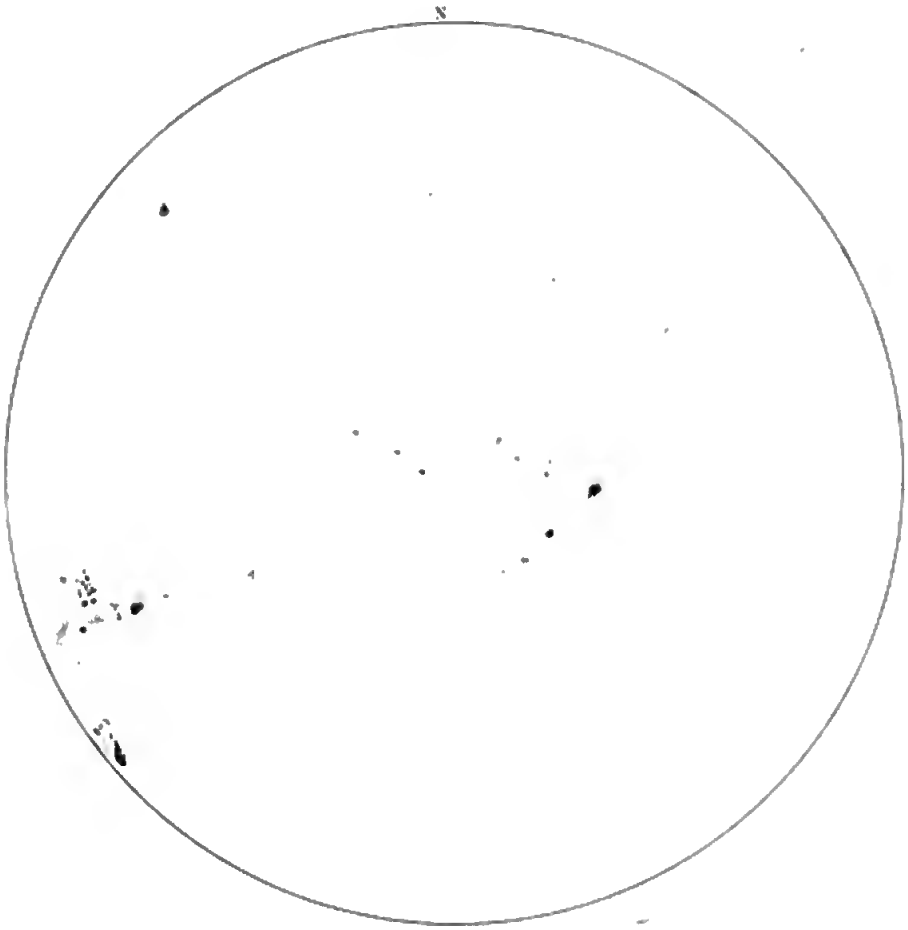

Sept. 20th

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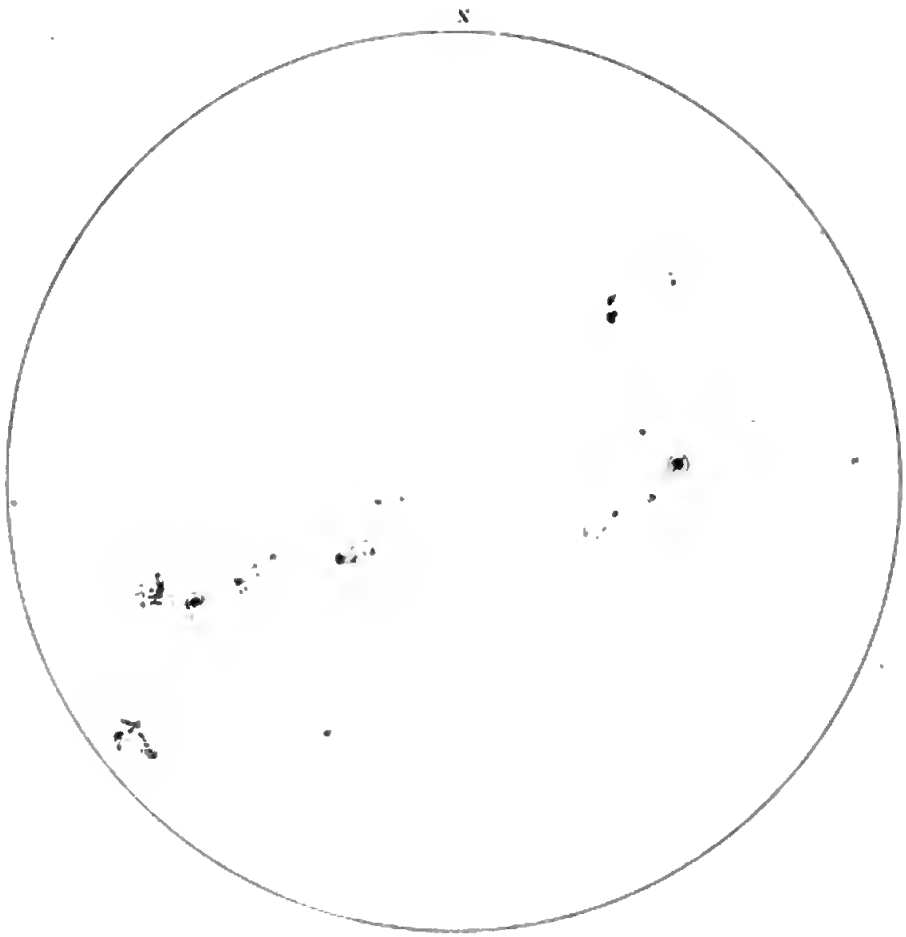

Sept. 21st

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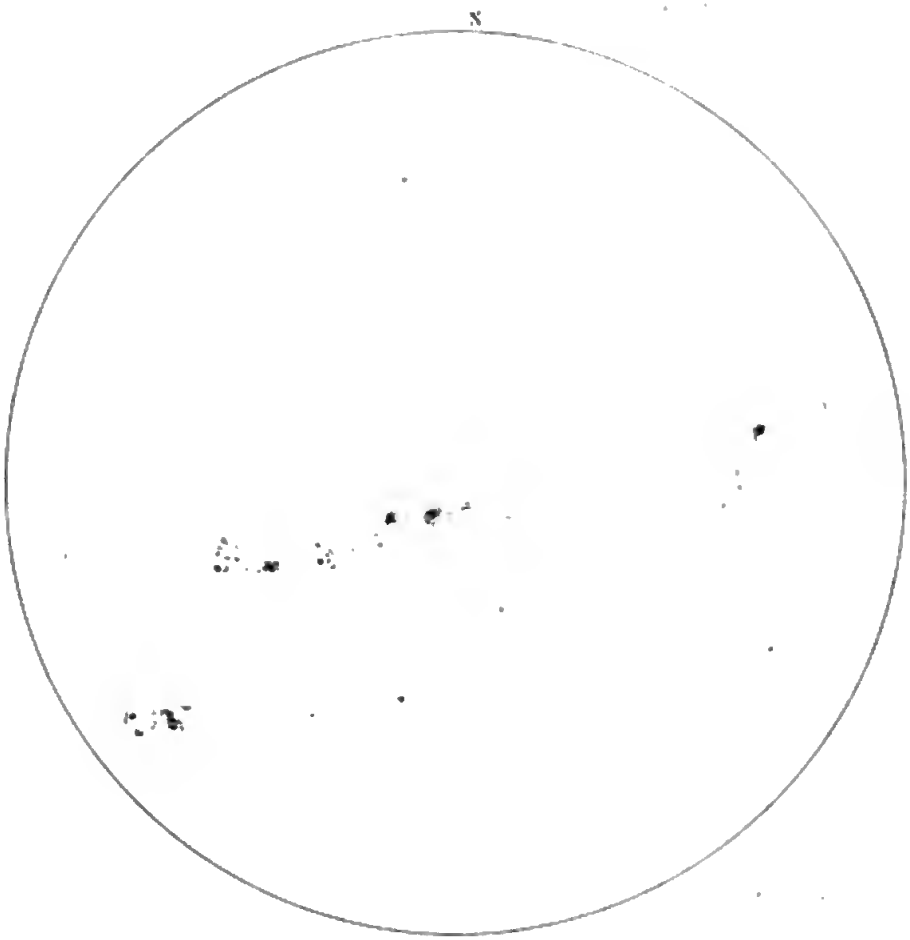

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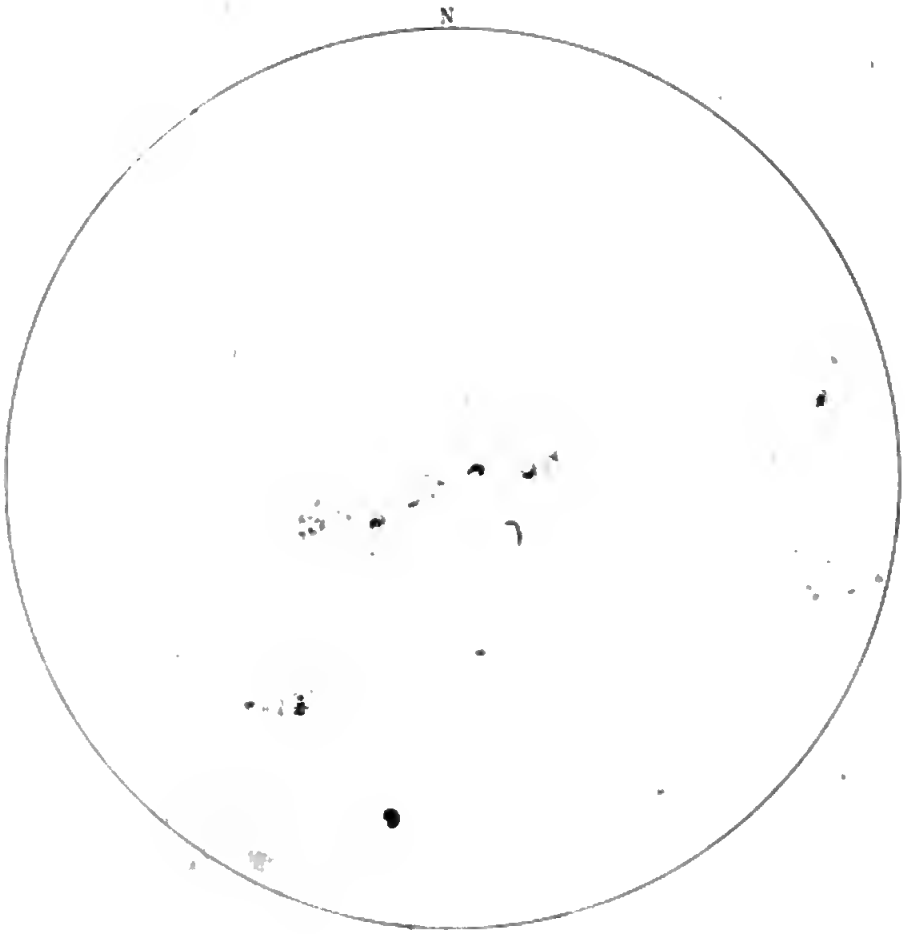

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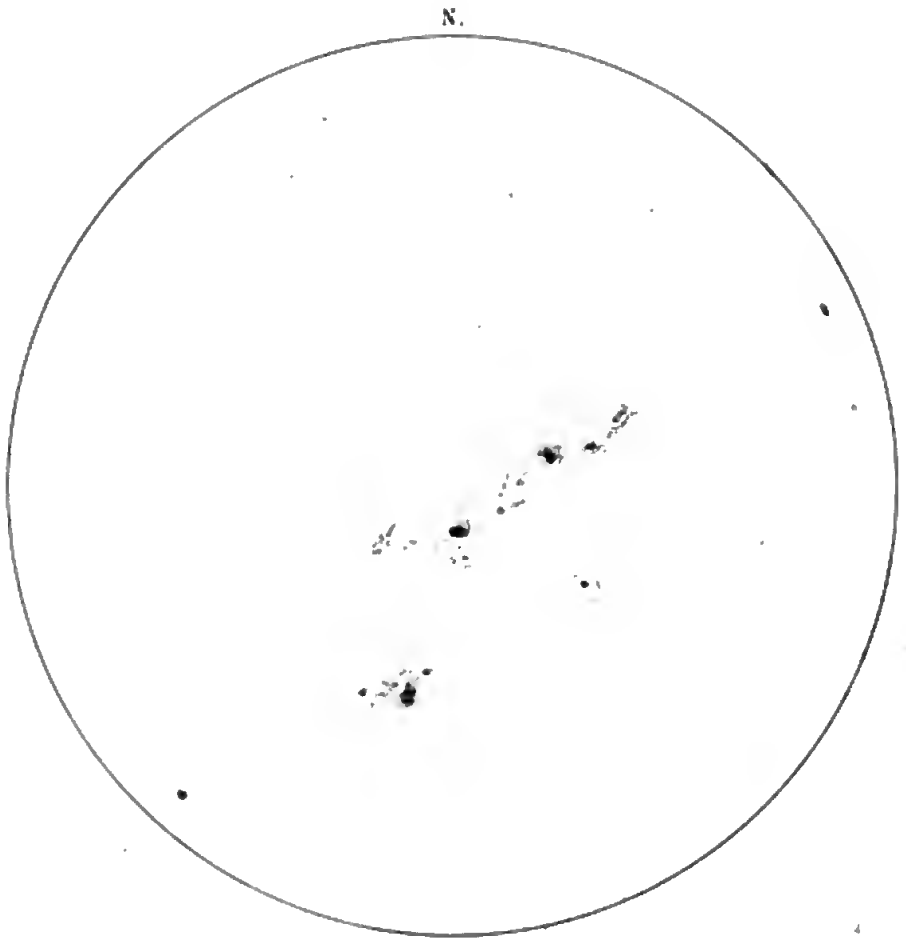

Sept. 24th

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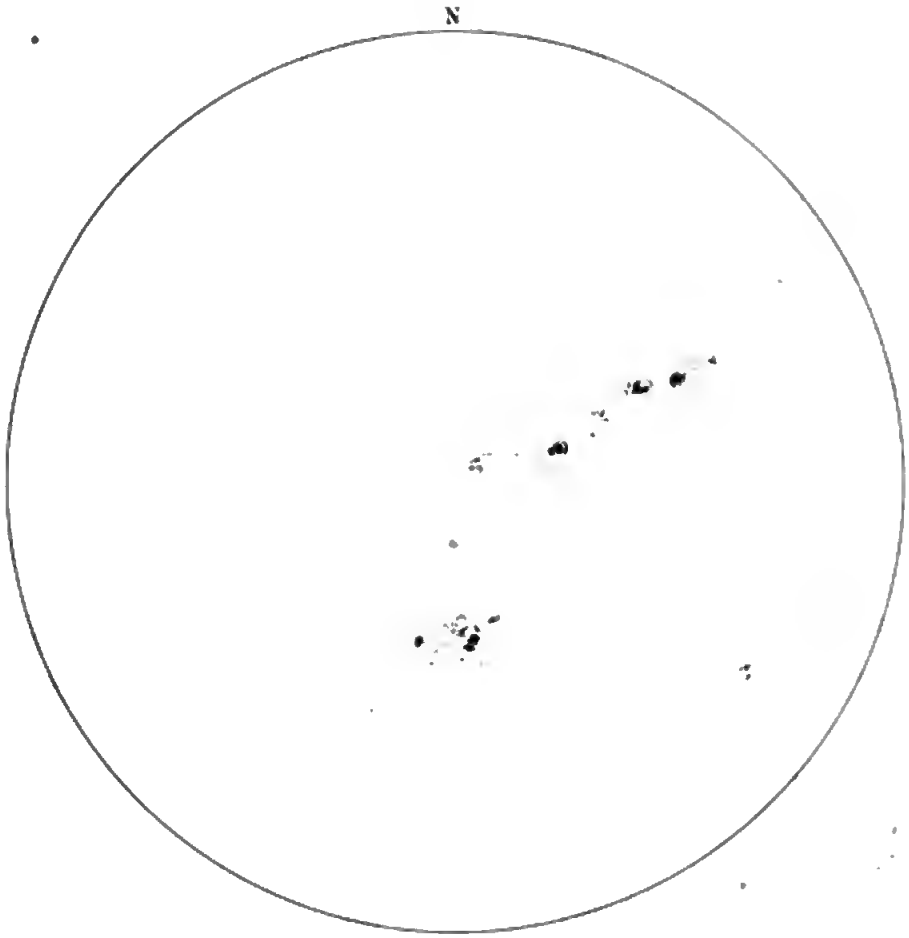

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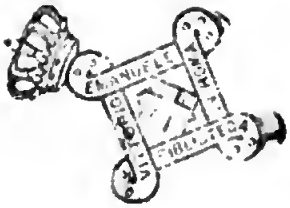

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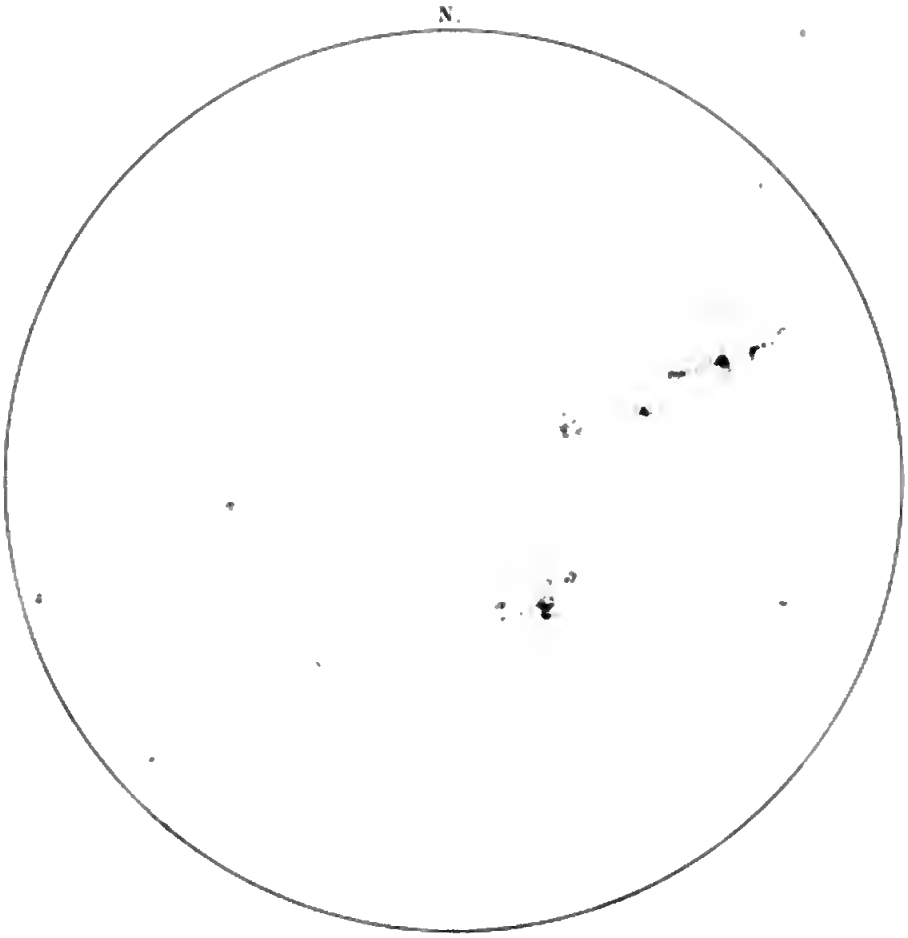

Sept. 26th

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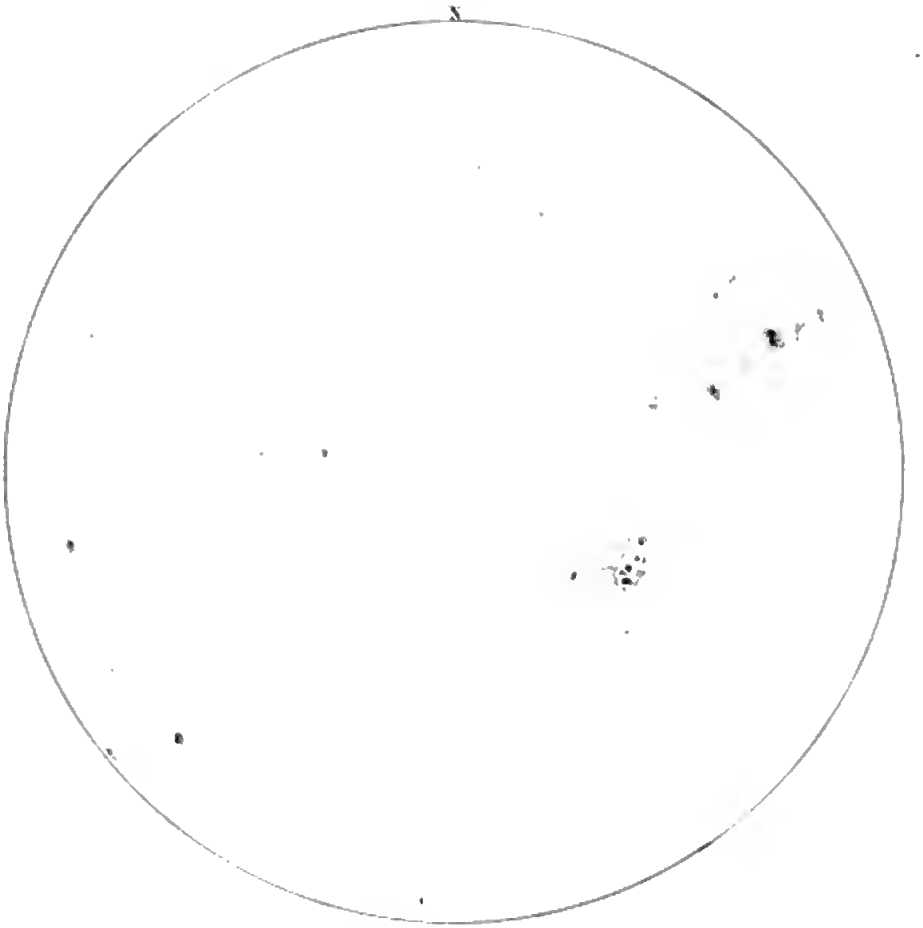

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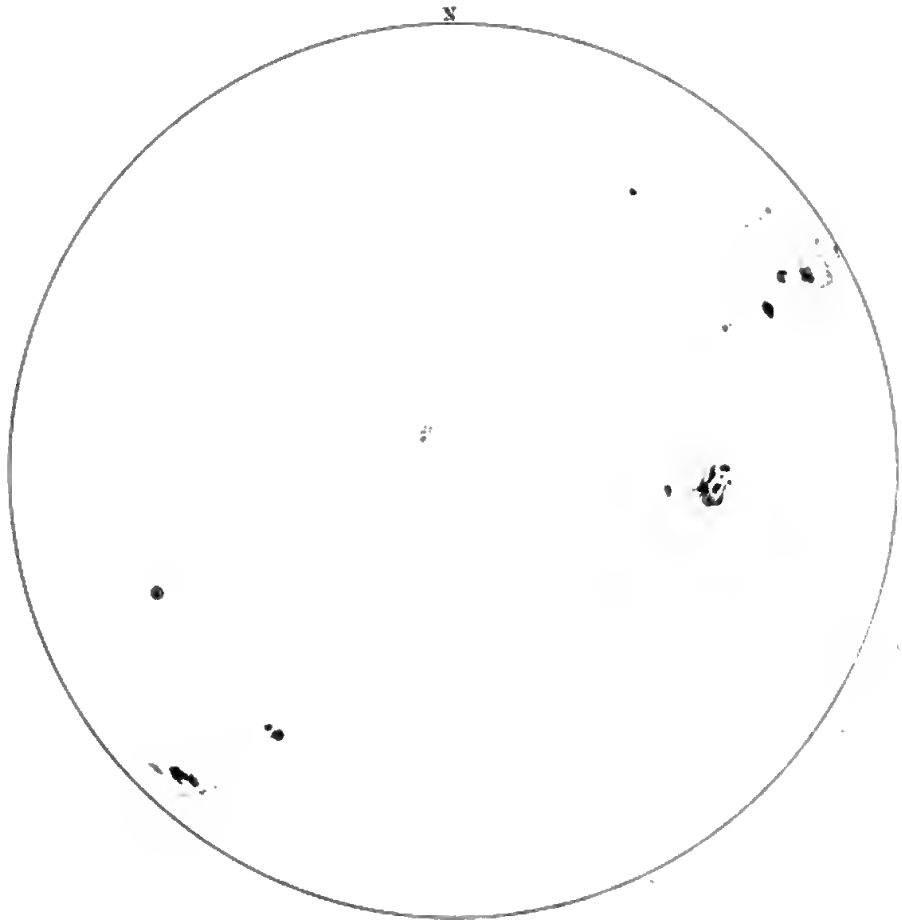

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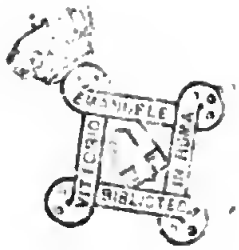

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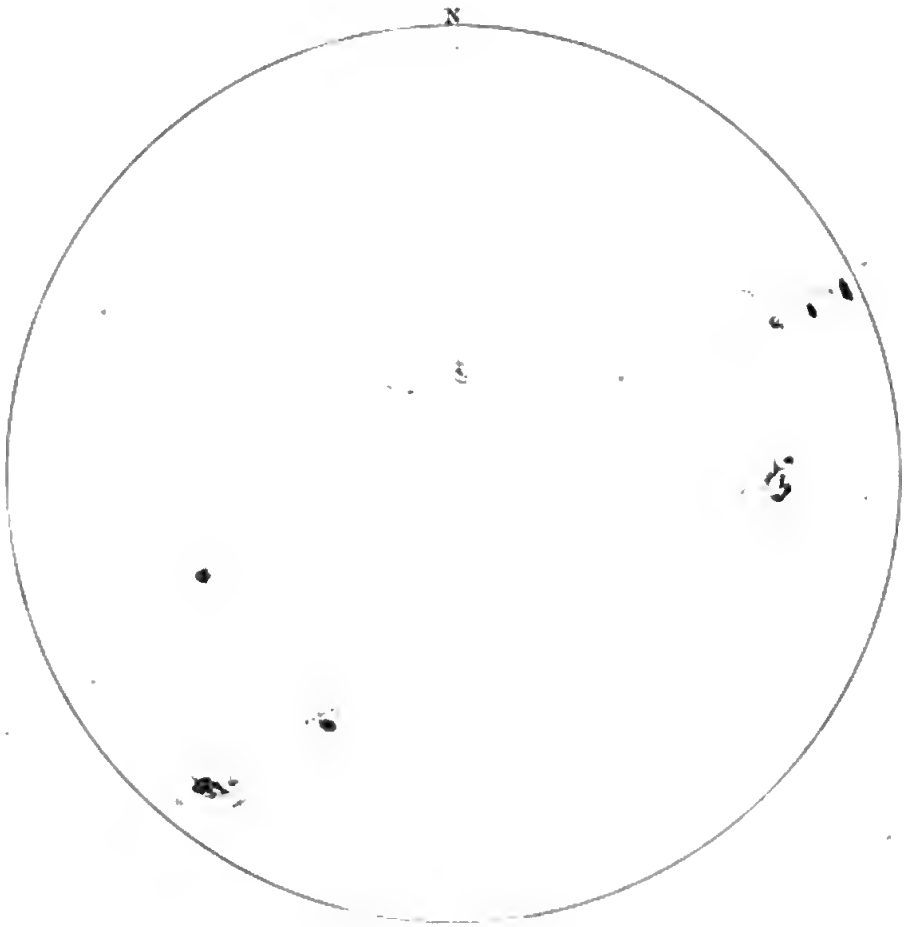

Sept. 29th

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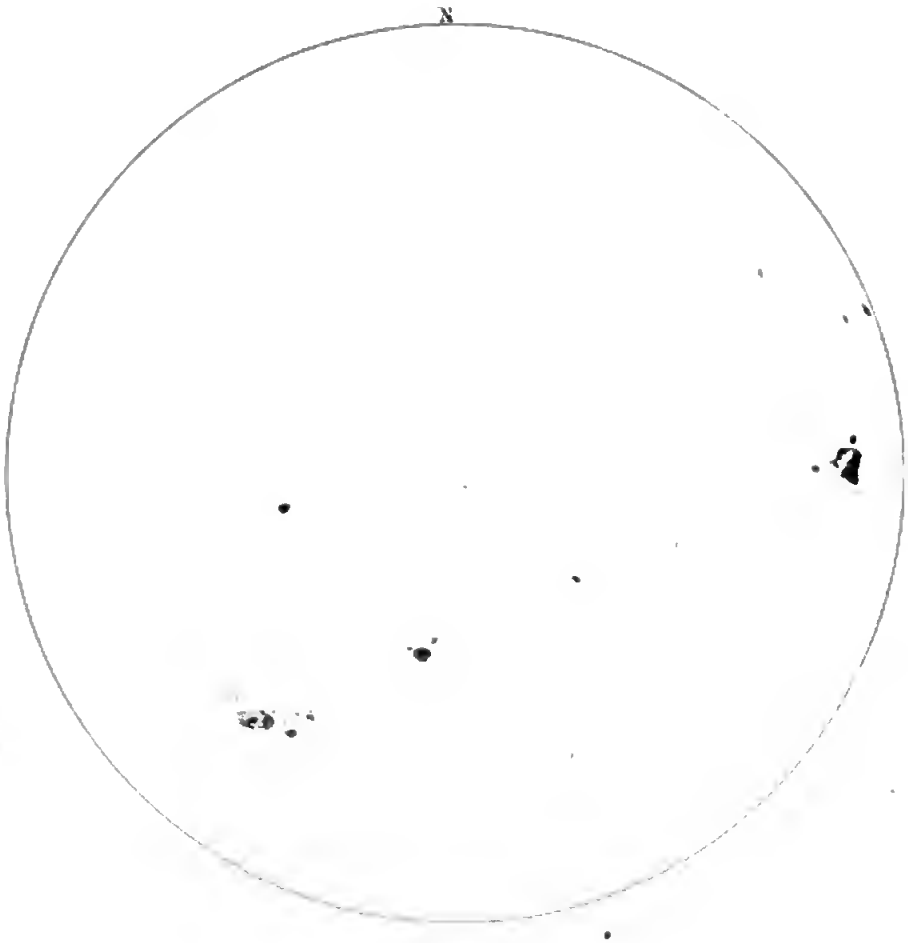

Sept. 30th

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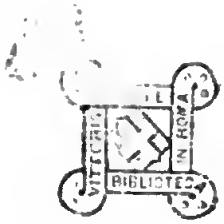

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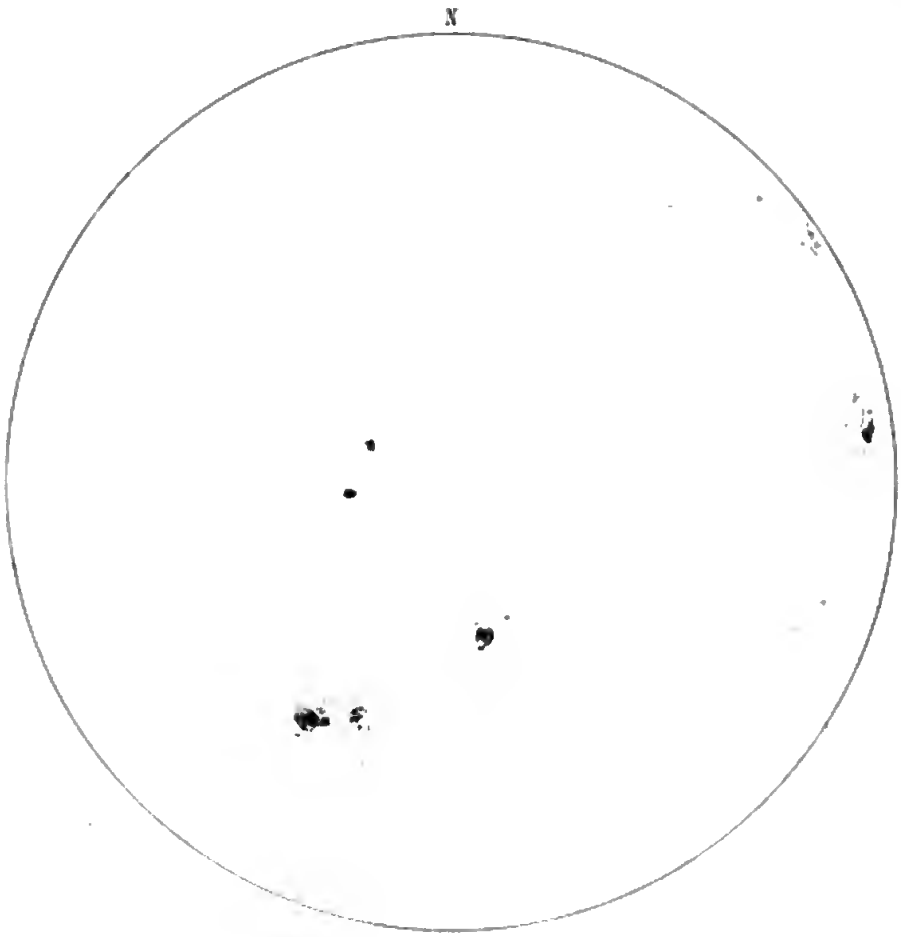

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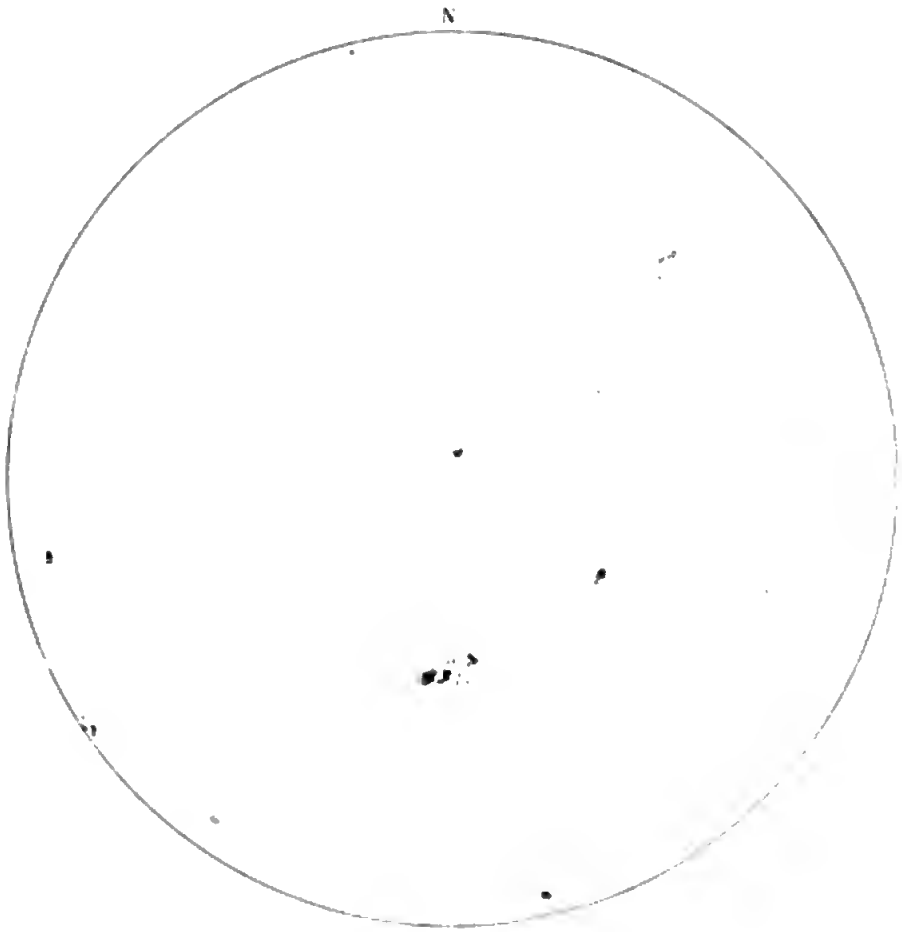

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VITTORIO EMANUELE
BIBLIOT. NAZ. IN ROMA

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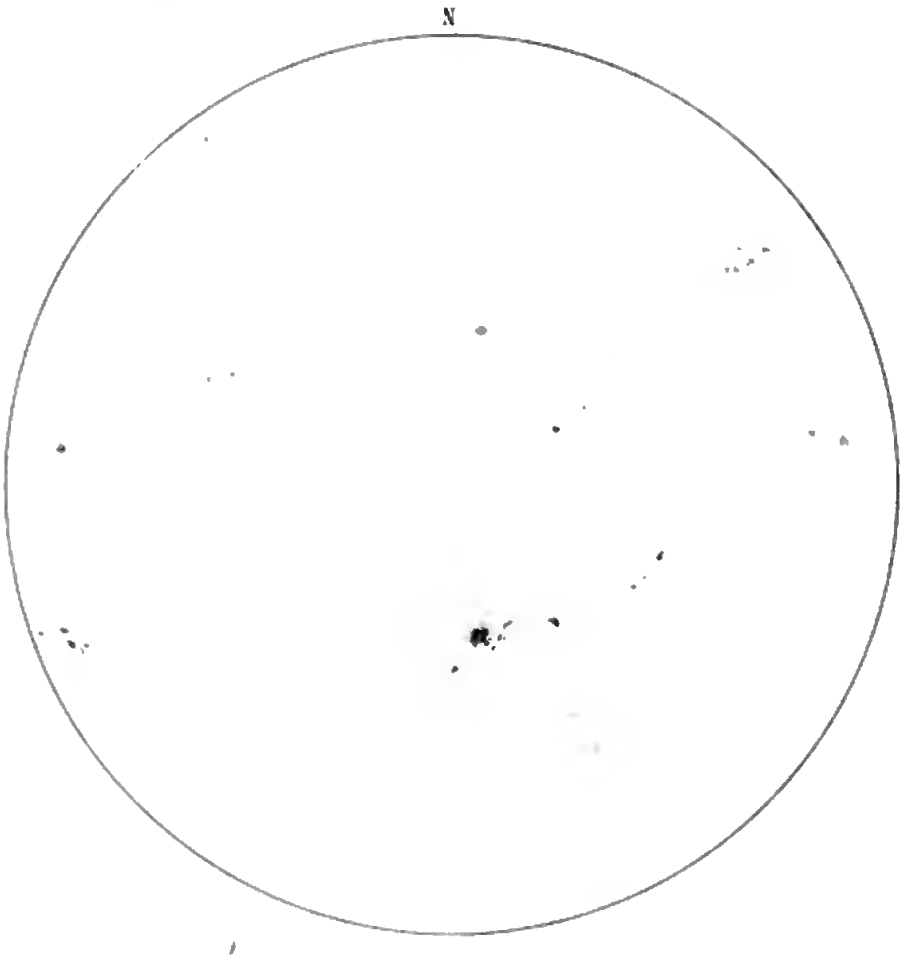

Oct 3d

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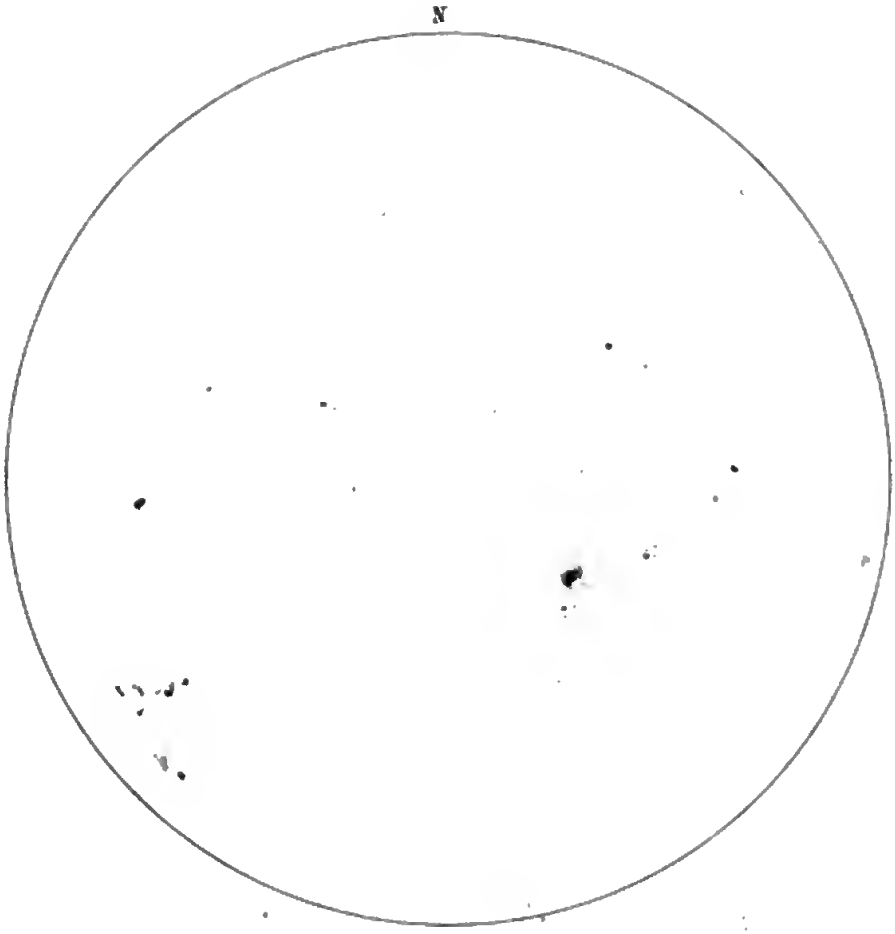
Sestinis Sun Spots

Plate XVI.



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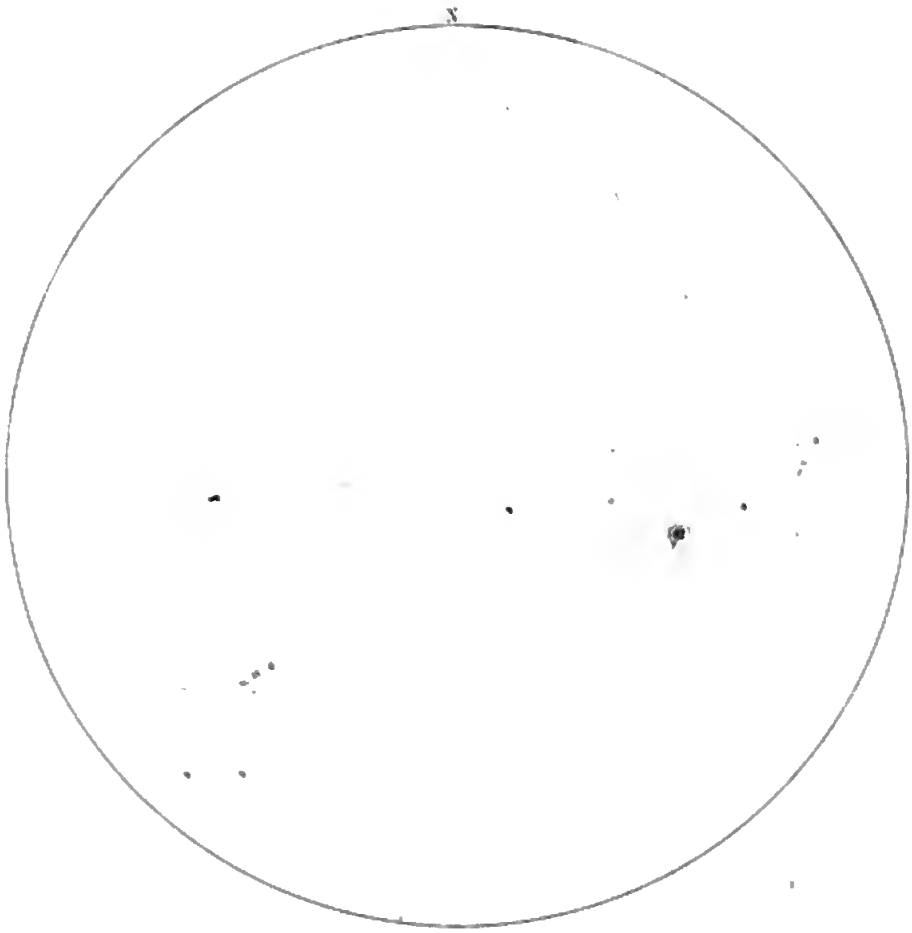

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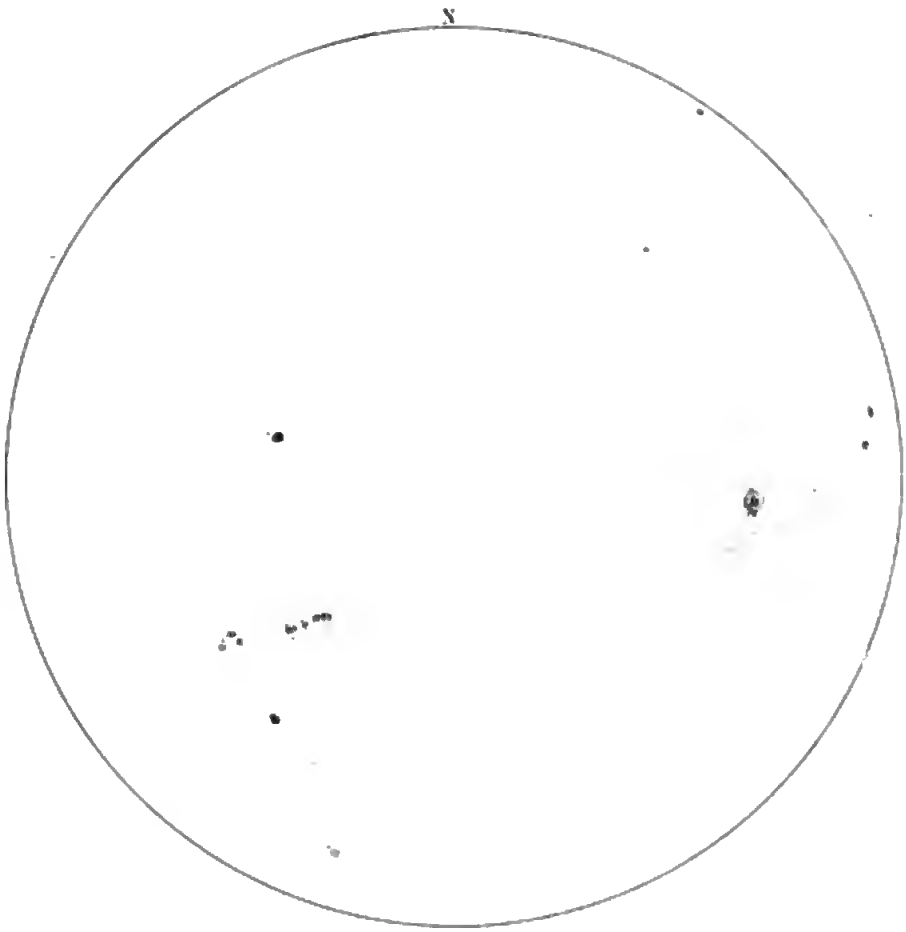

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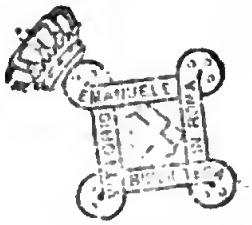

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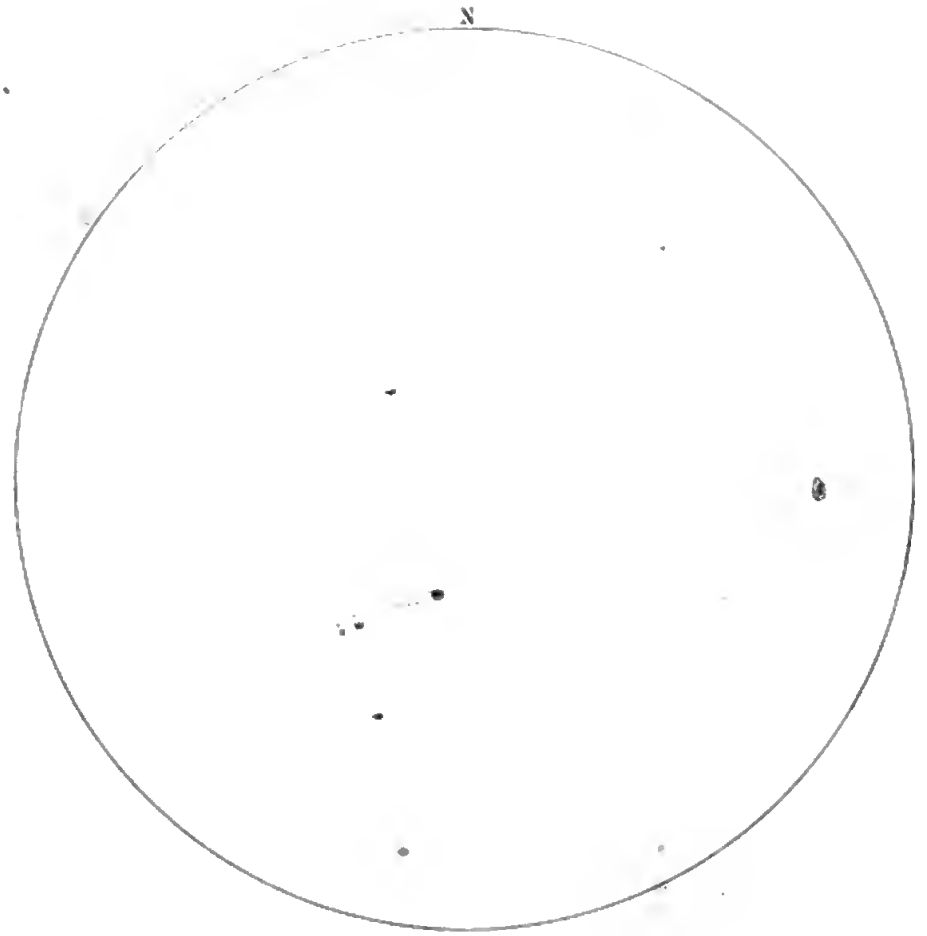

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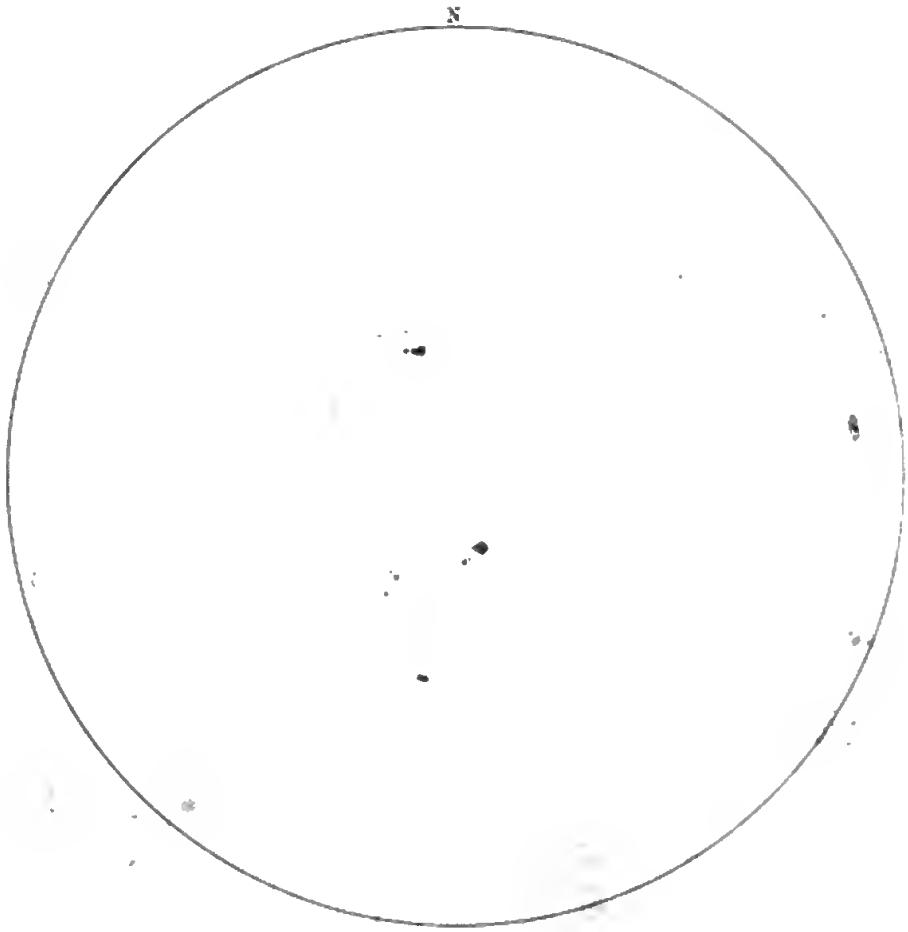

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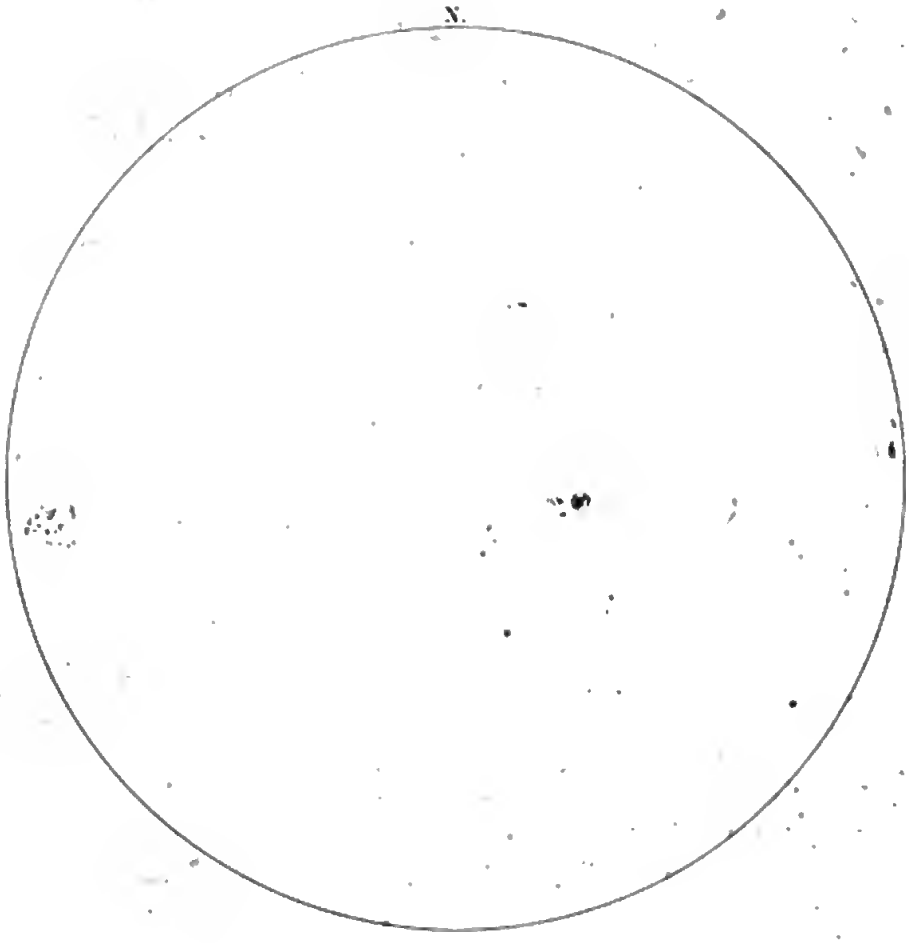

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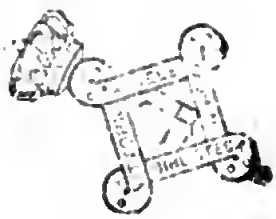

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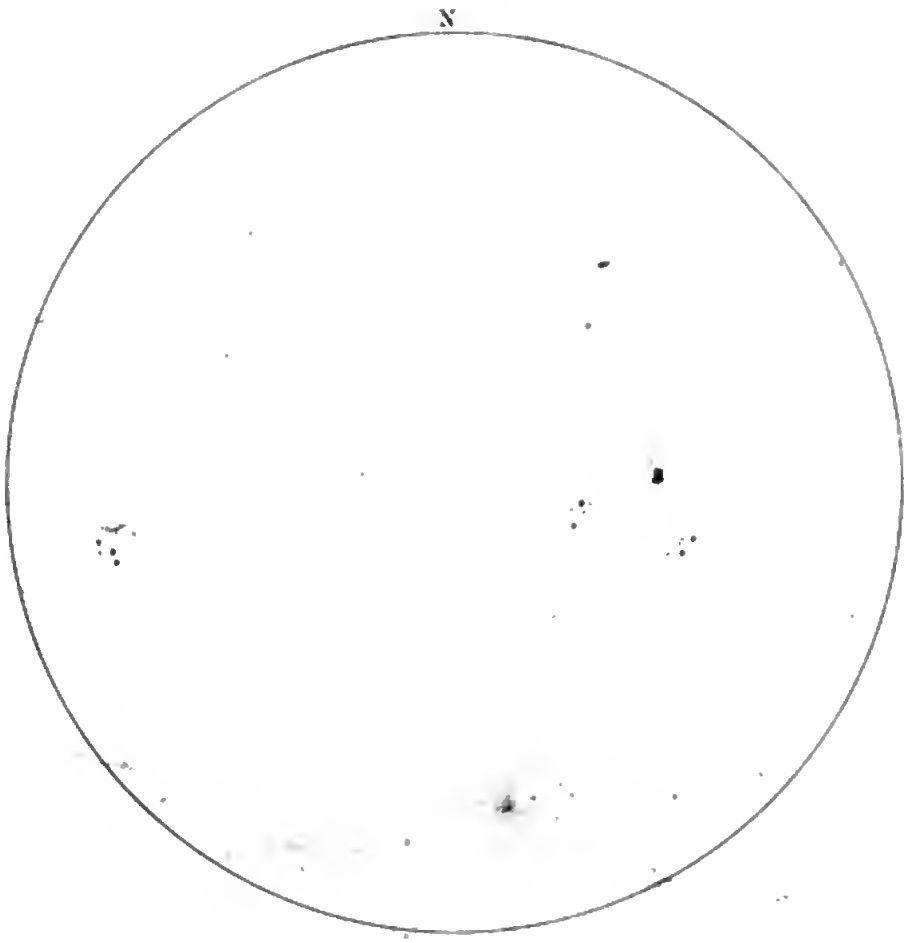

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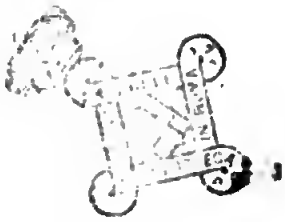

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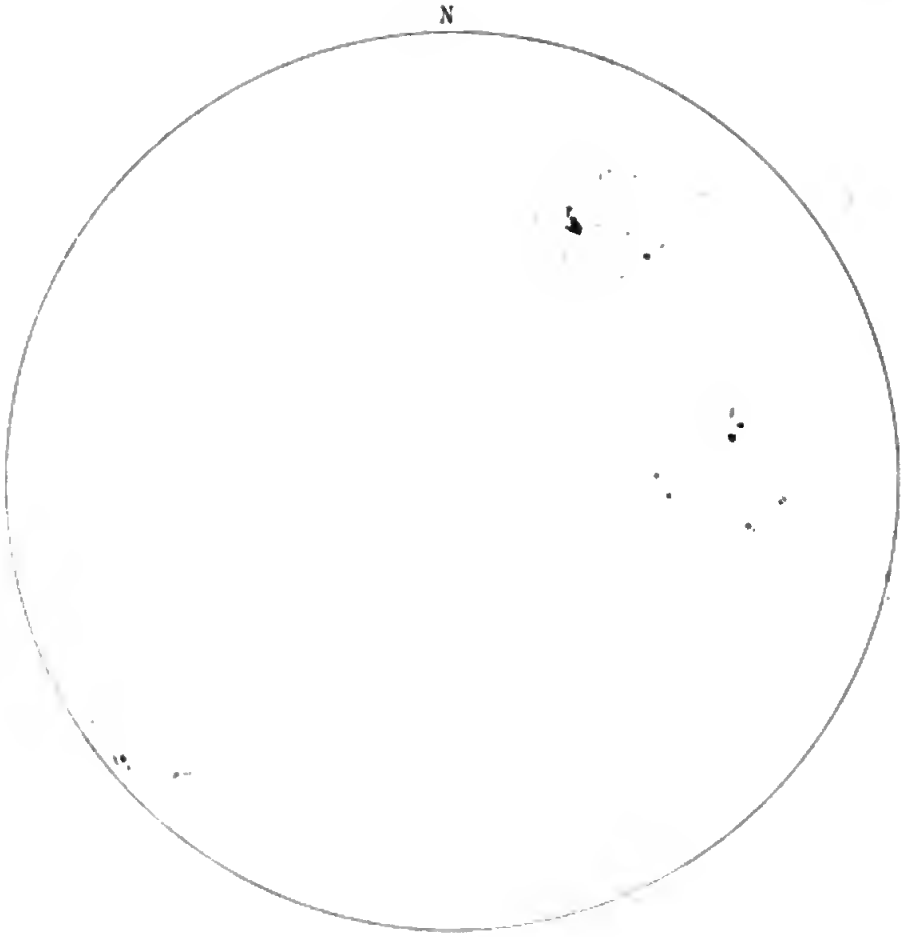

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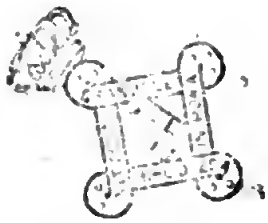

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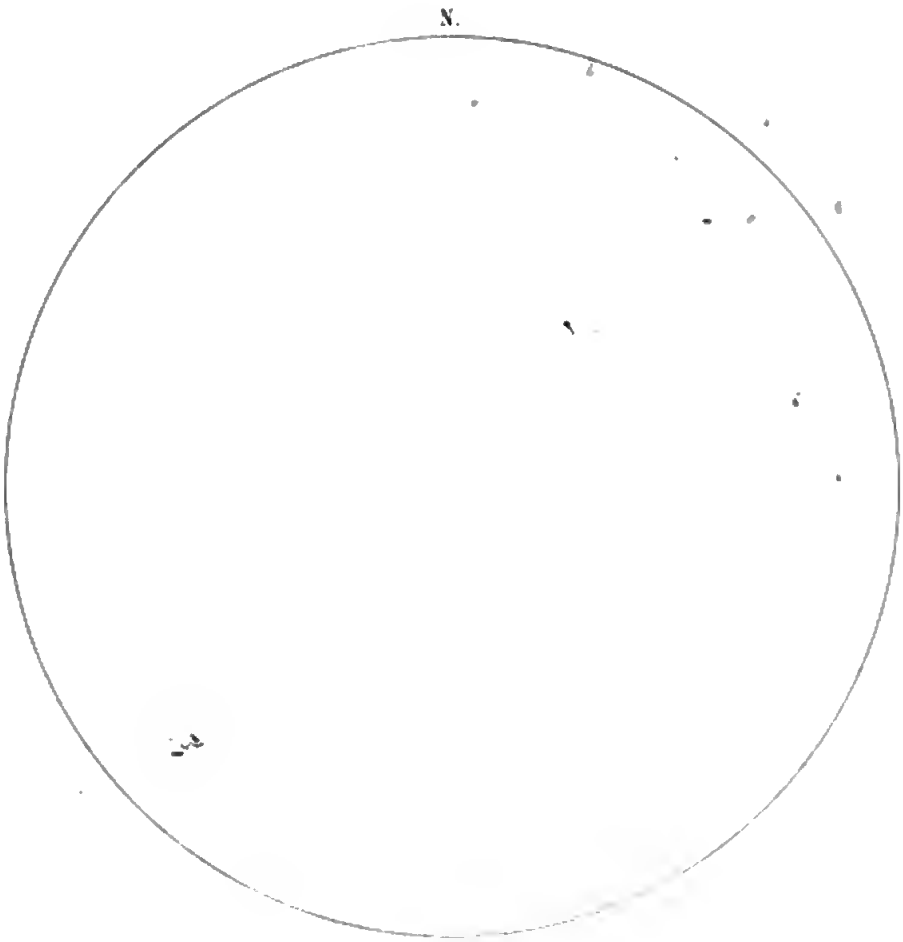

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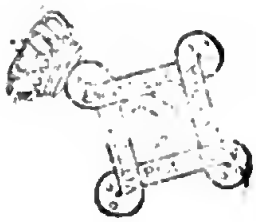

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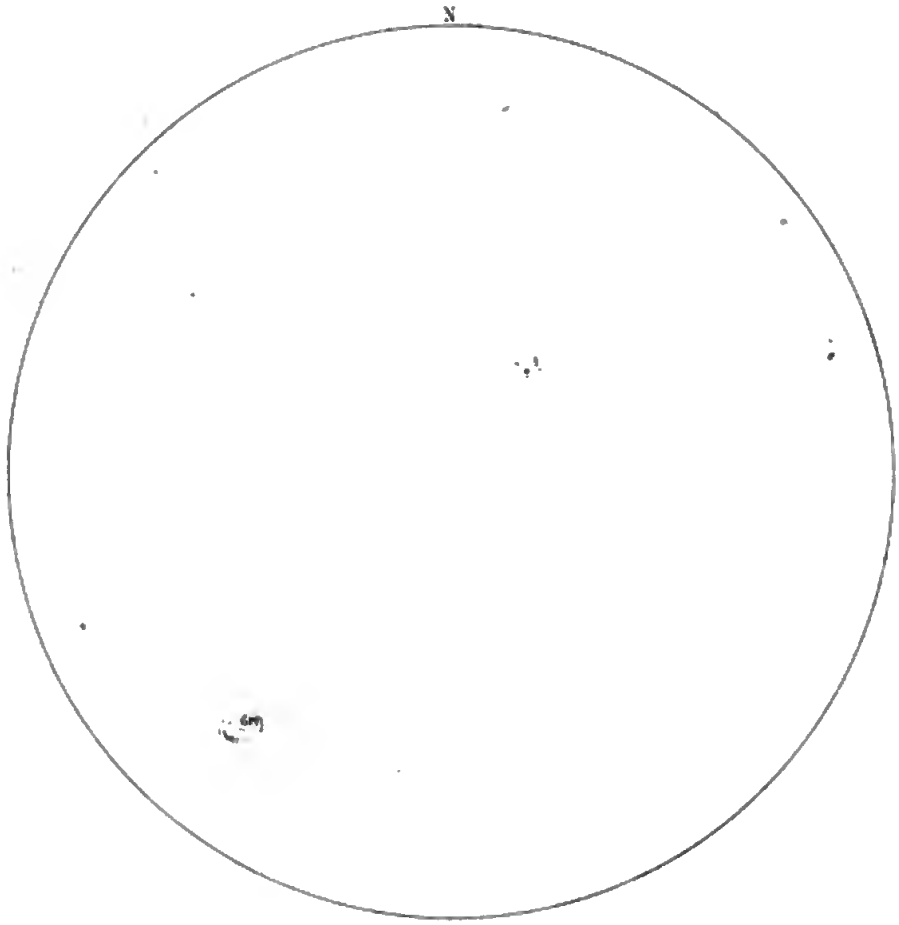

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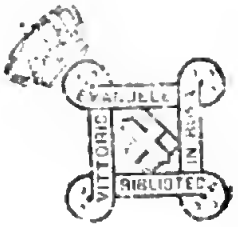

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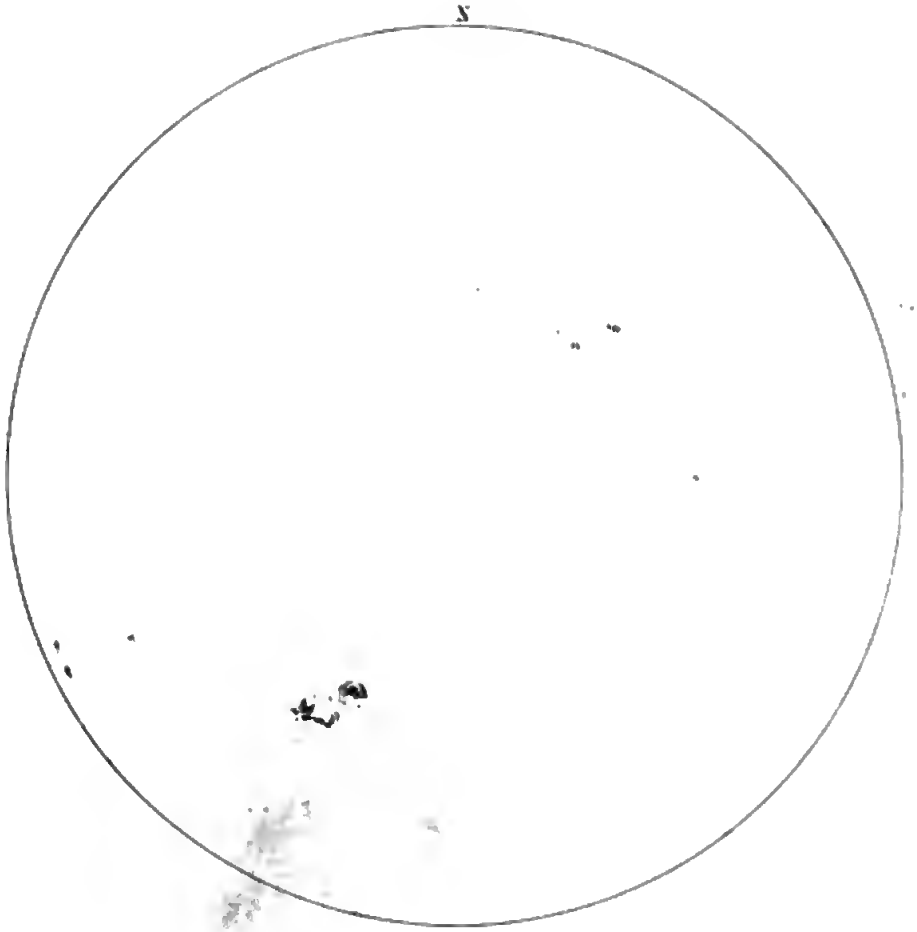

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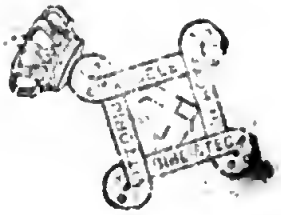

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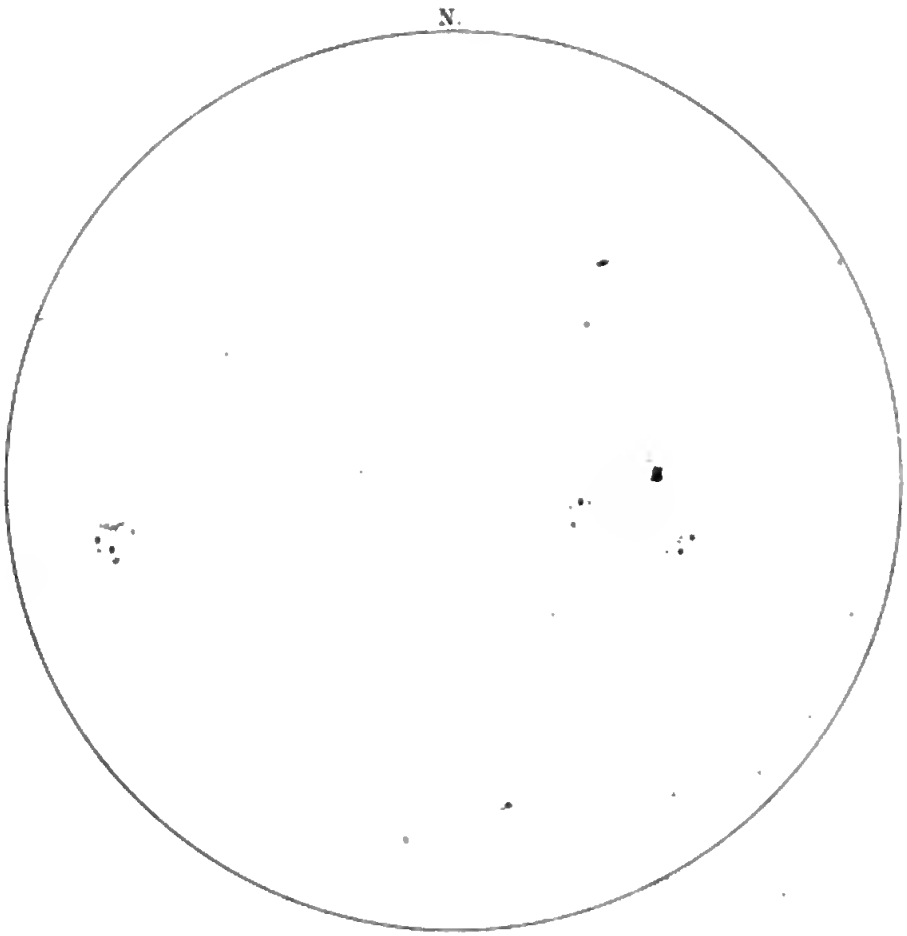

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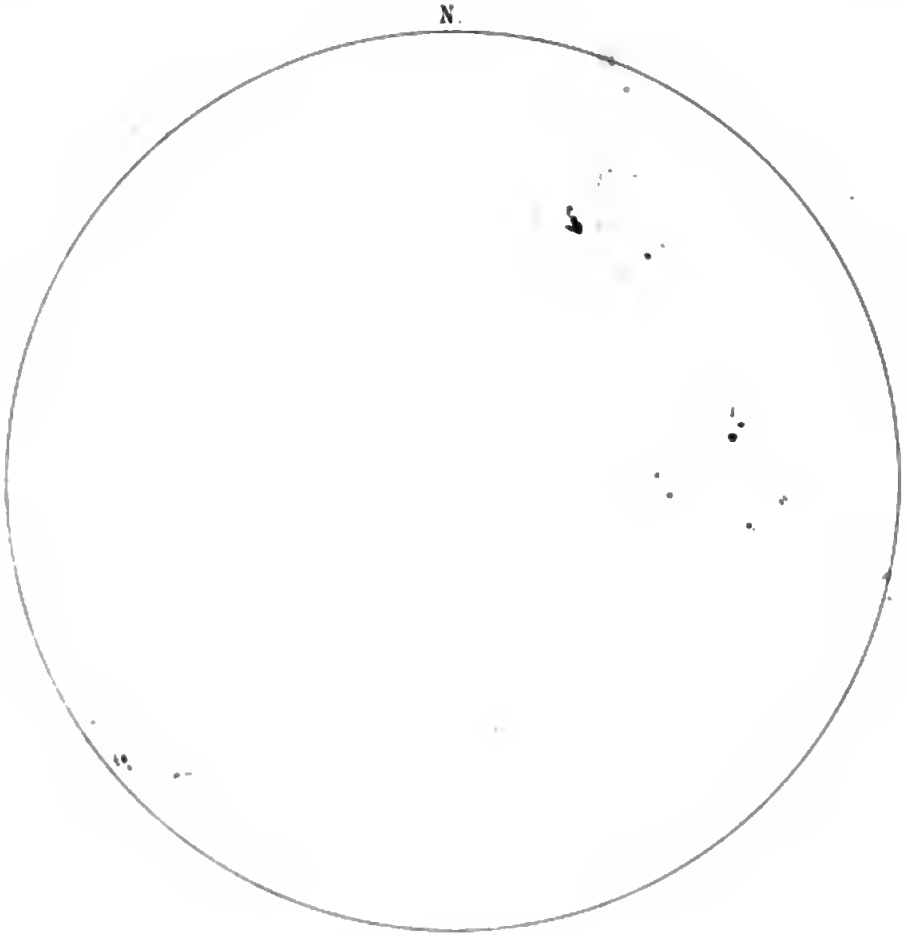

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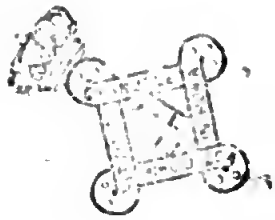

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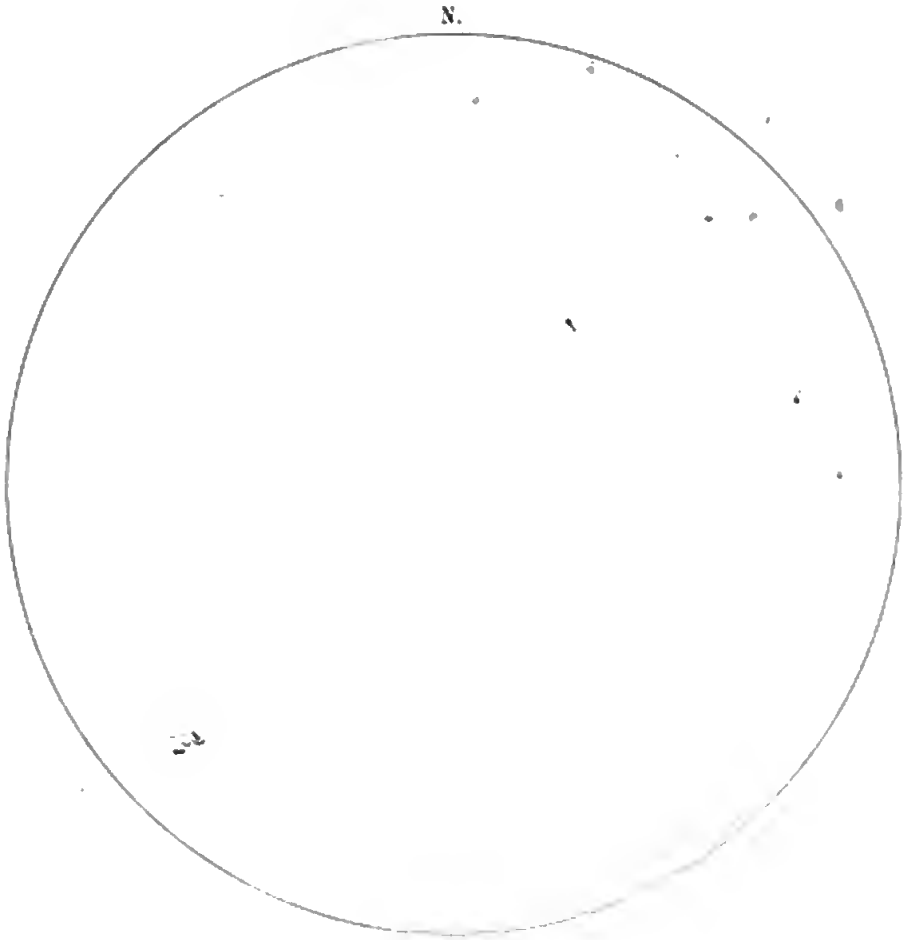

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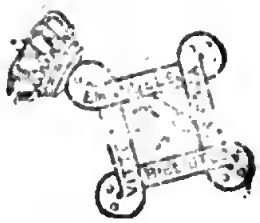

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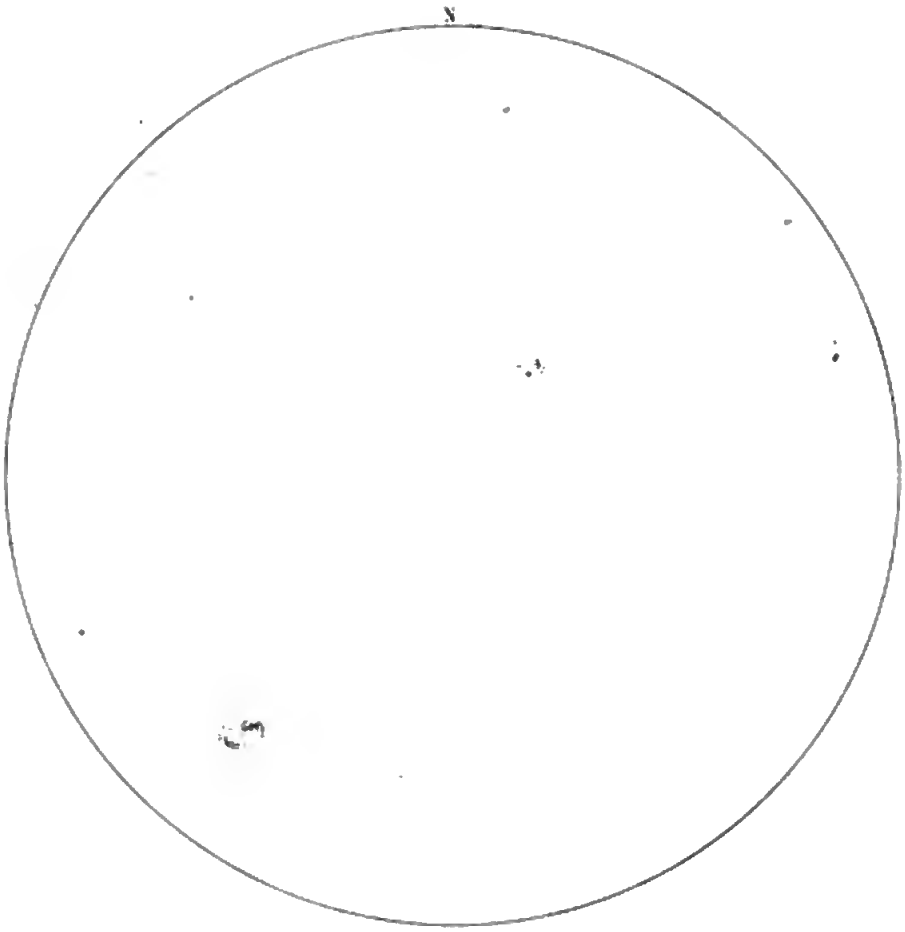

Oct 13th

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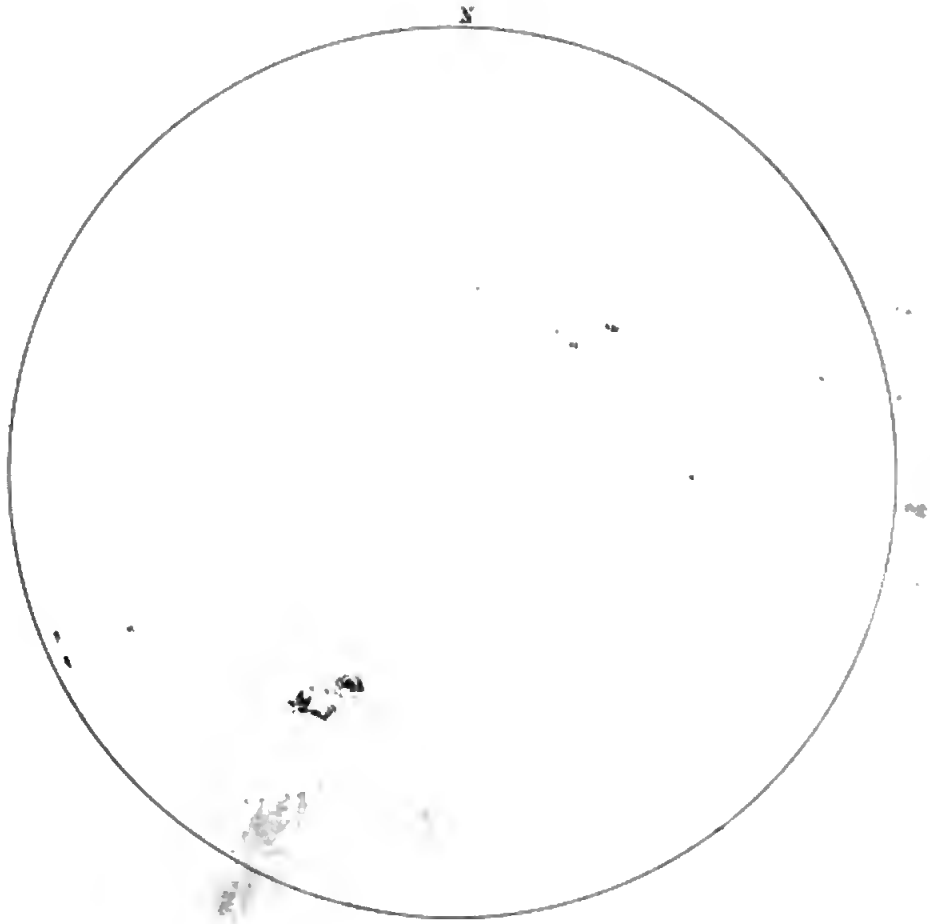
VITTORIO EMANUELE
BIBLIOTECA NAZIONALE

Digitized by Google



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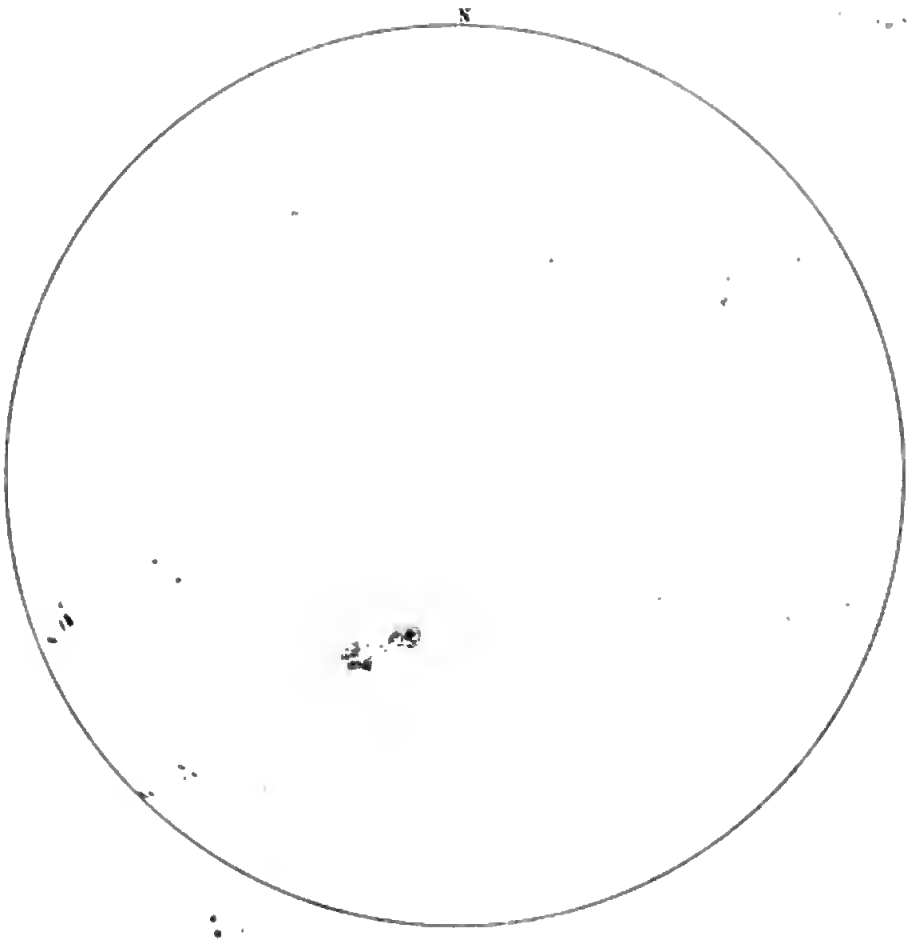

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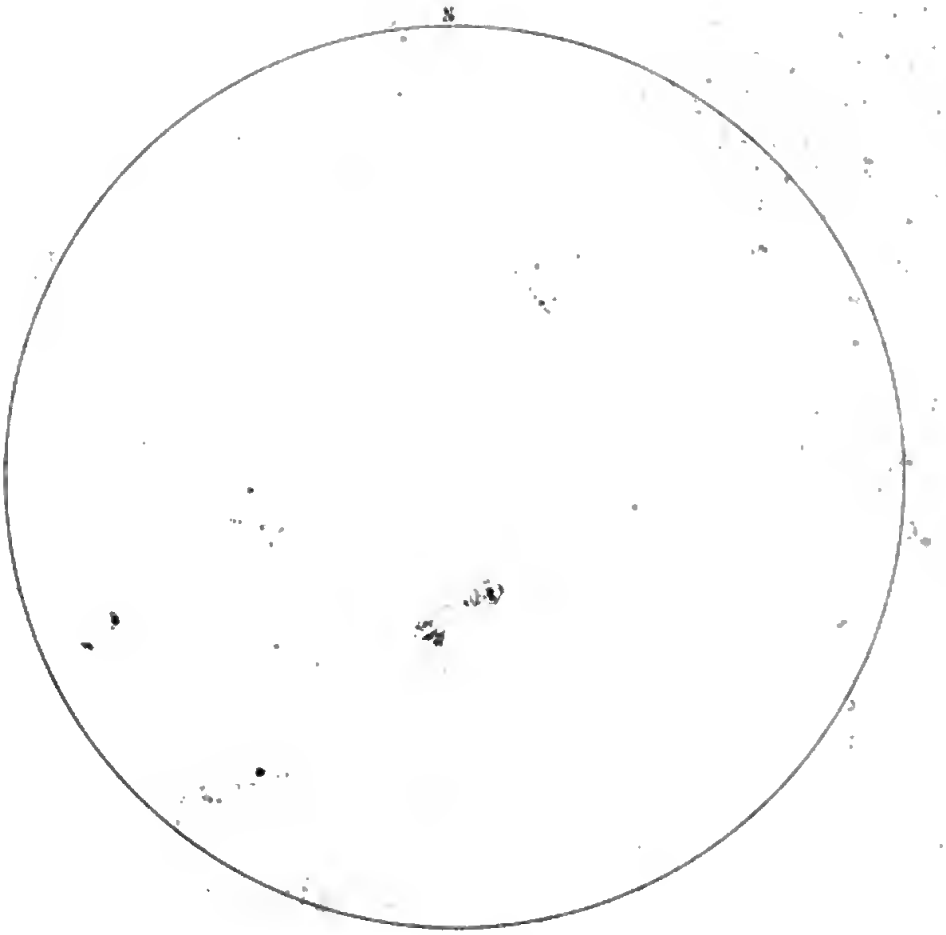

Oct 16th

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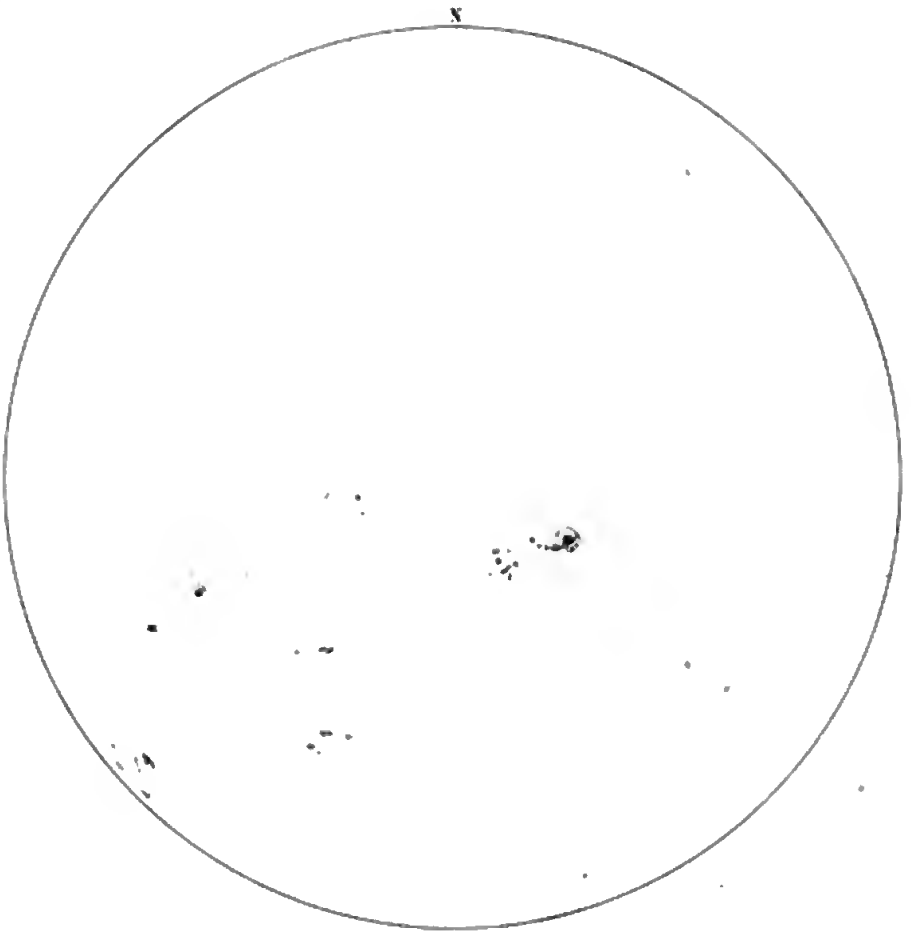

Oct. 17th

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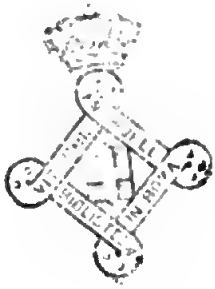

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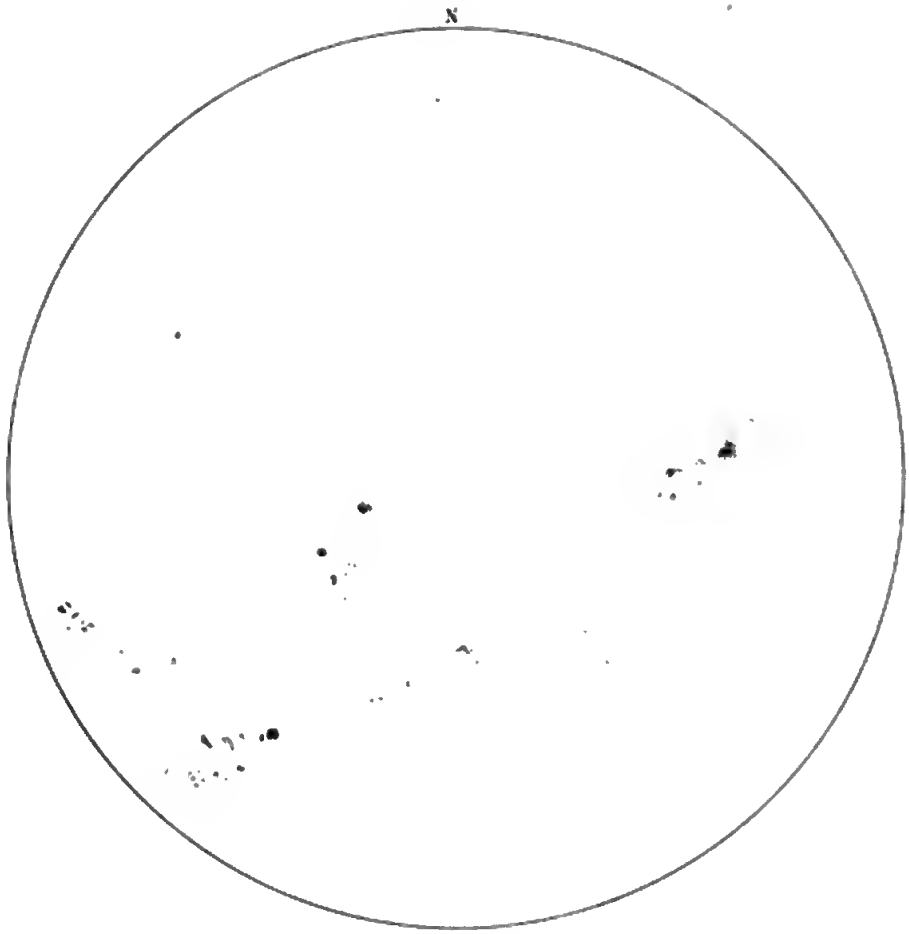

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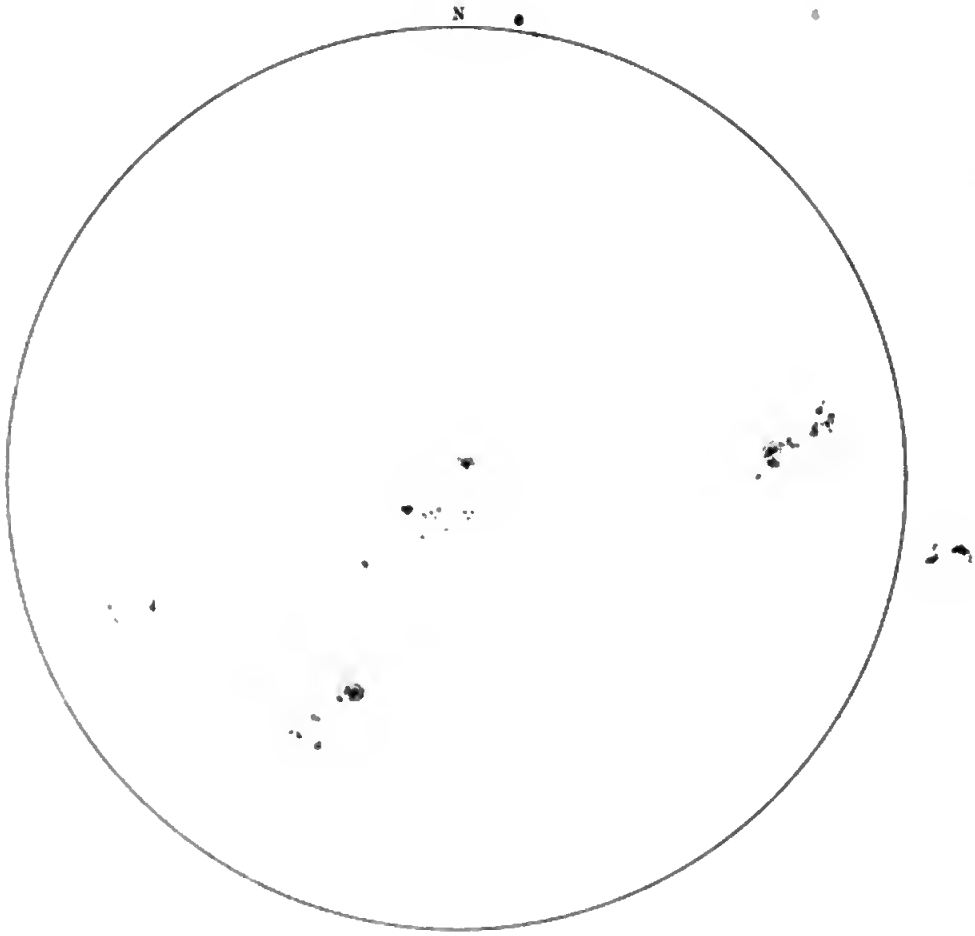

Oct. 20th

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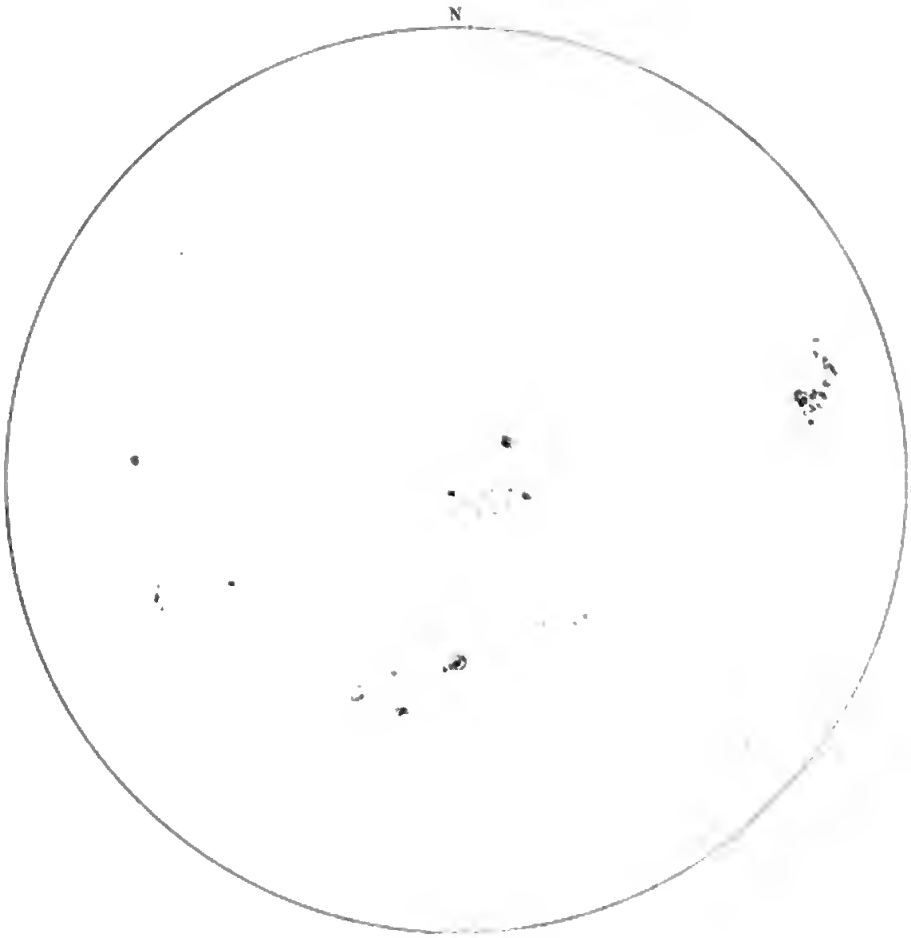

Oct 21st

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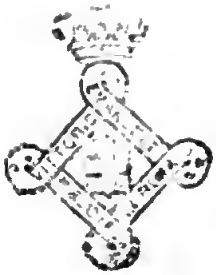

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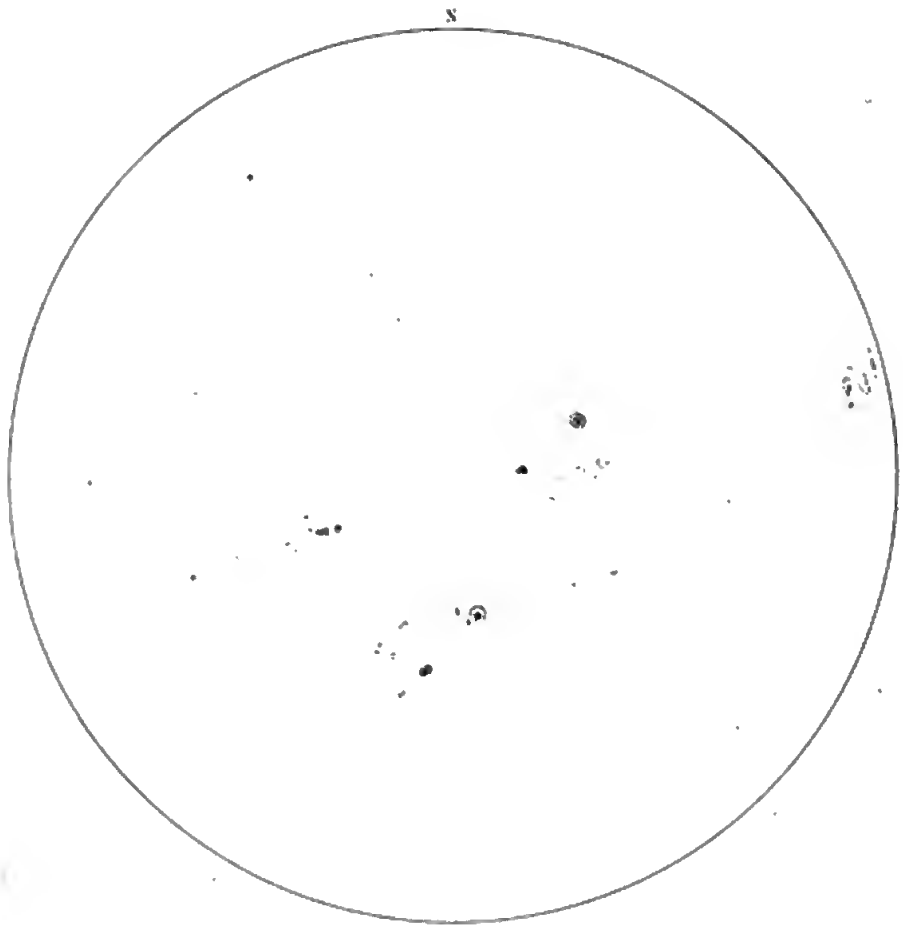

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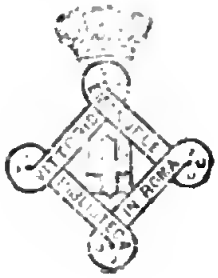

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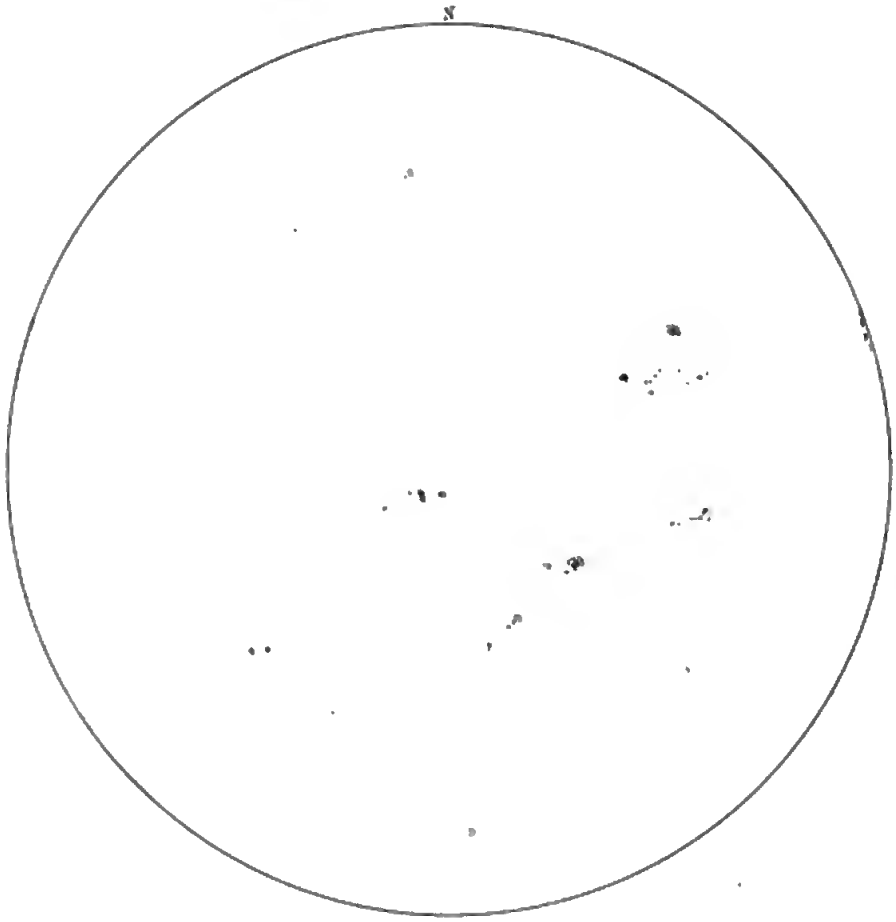

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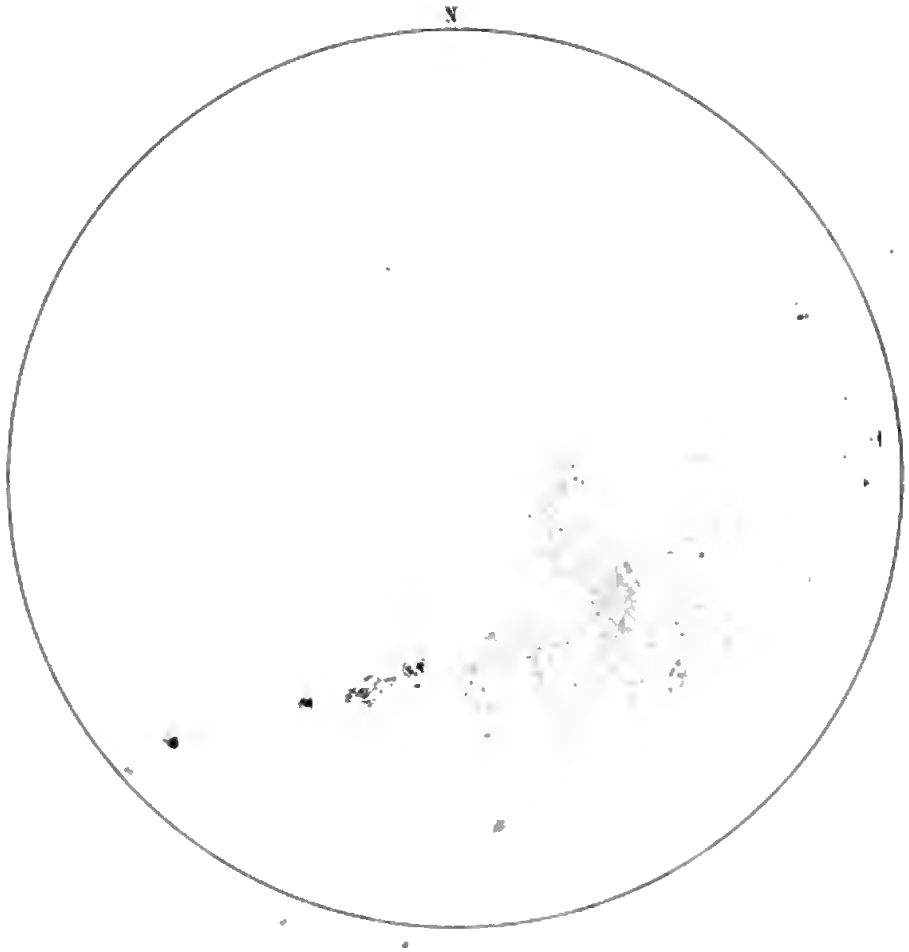

Oct 28th

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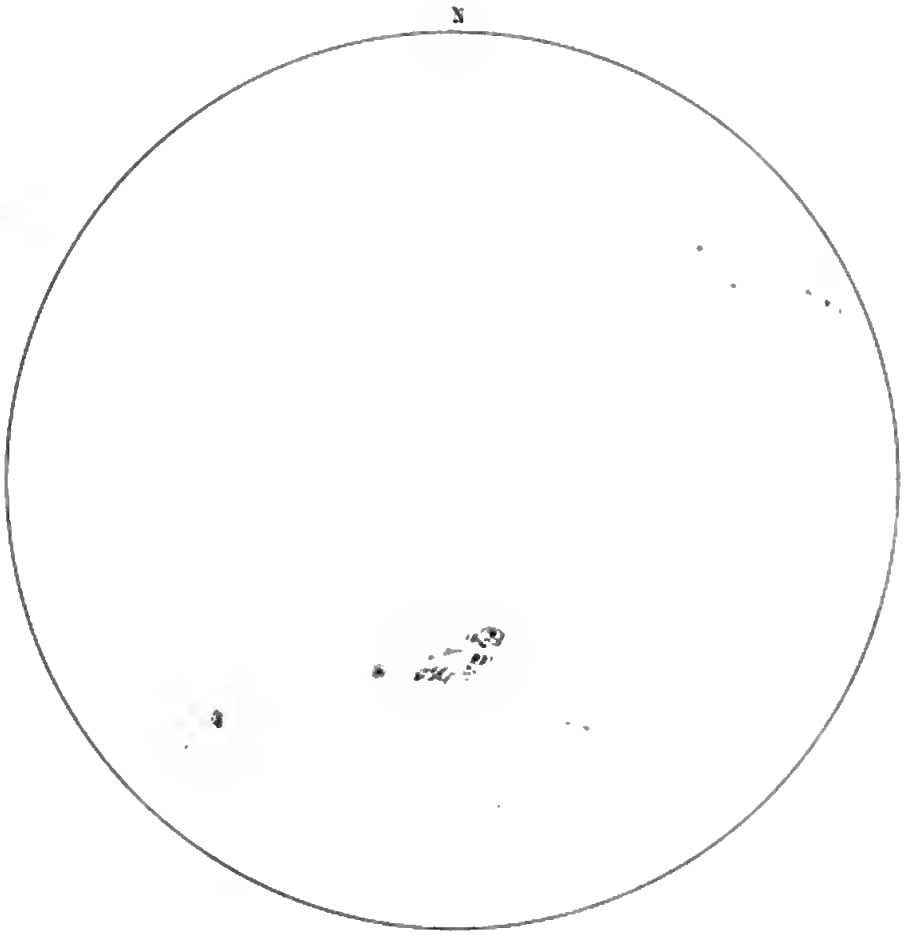

Oct. 29th

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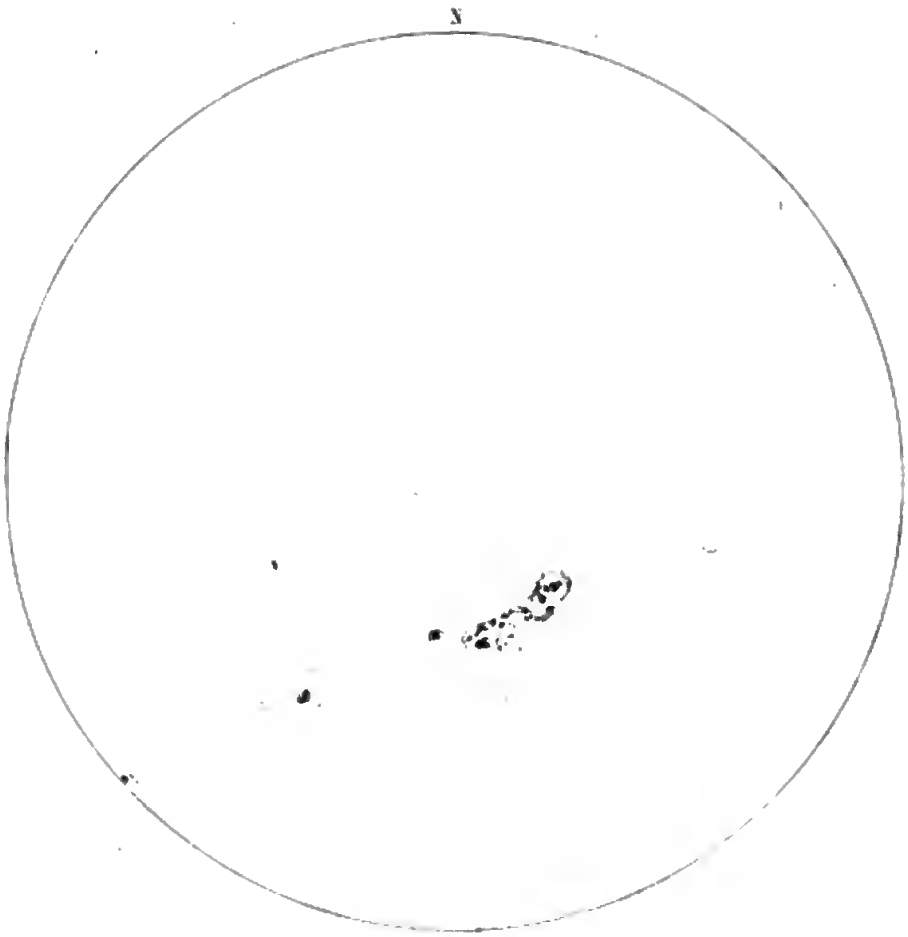

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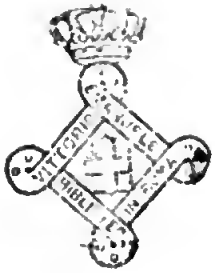

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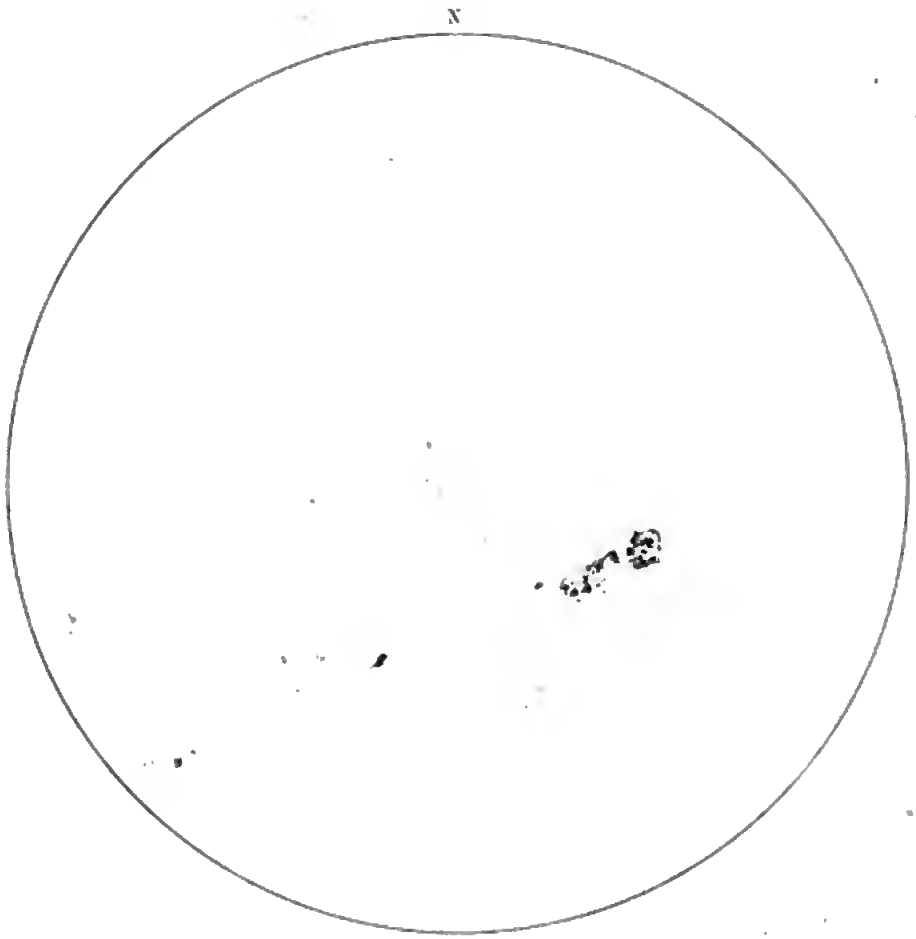

Oct. 31st

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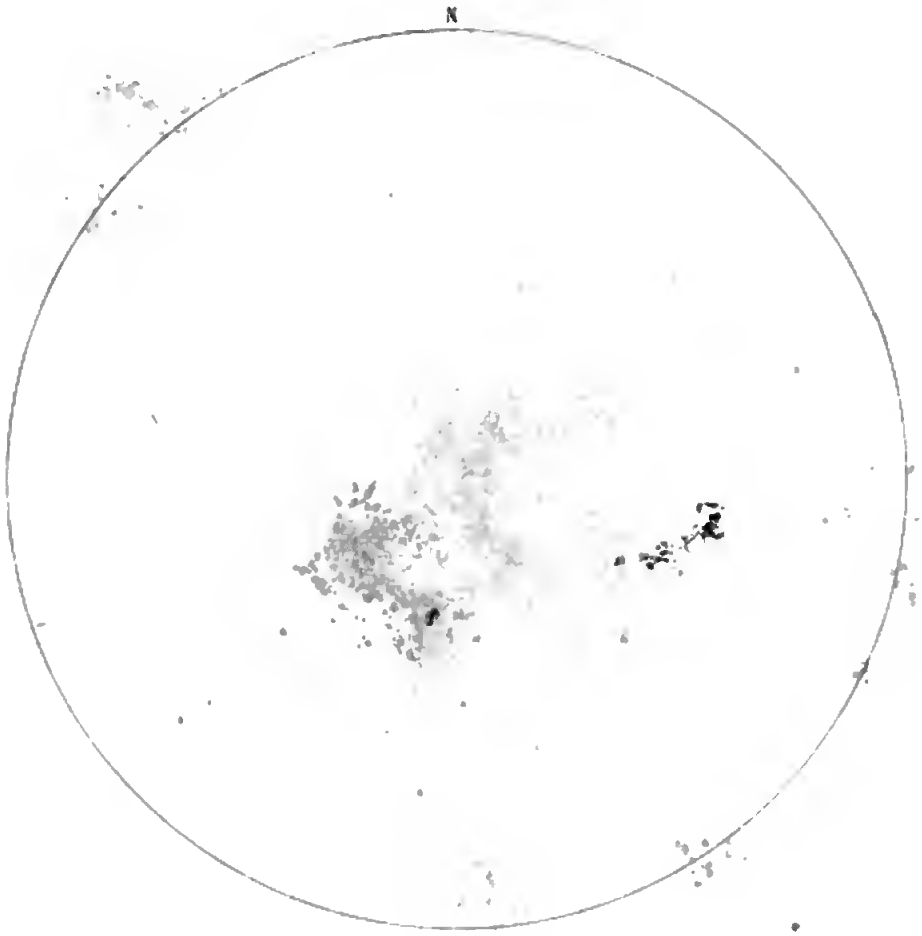


Nov 1st

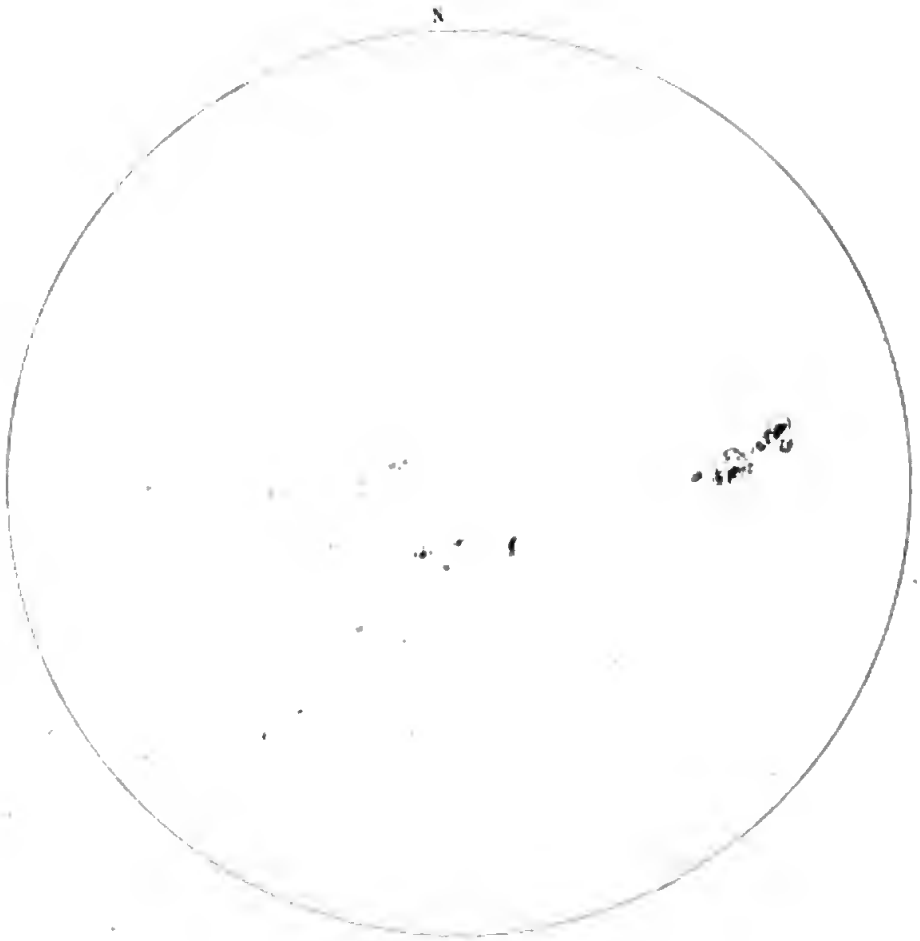
Digitized by Google

EMANUELE
LETTERARIA
BIBLIOTECA
IN ROMA

Digitized by Google

Sestinus Sun Spots

Plate XI.



Nov. 24

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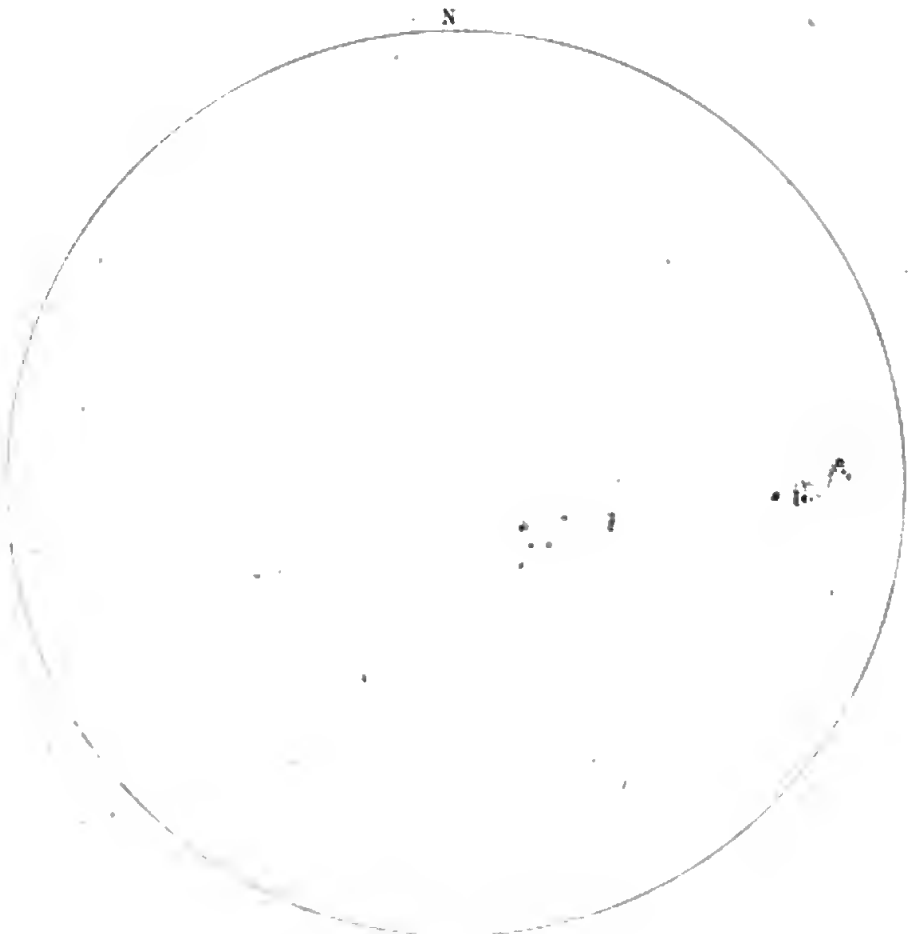

Ann. 3d

Digitized by Google

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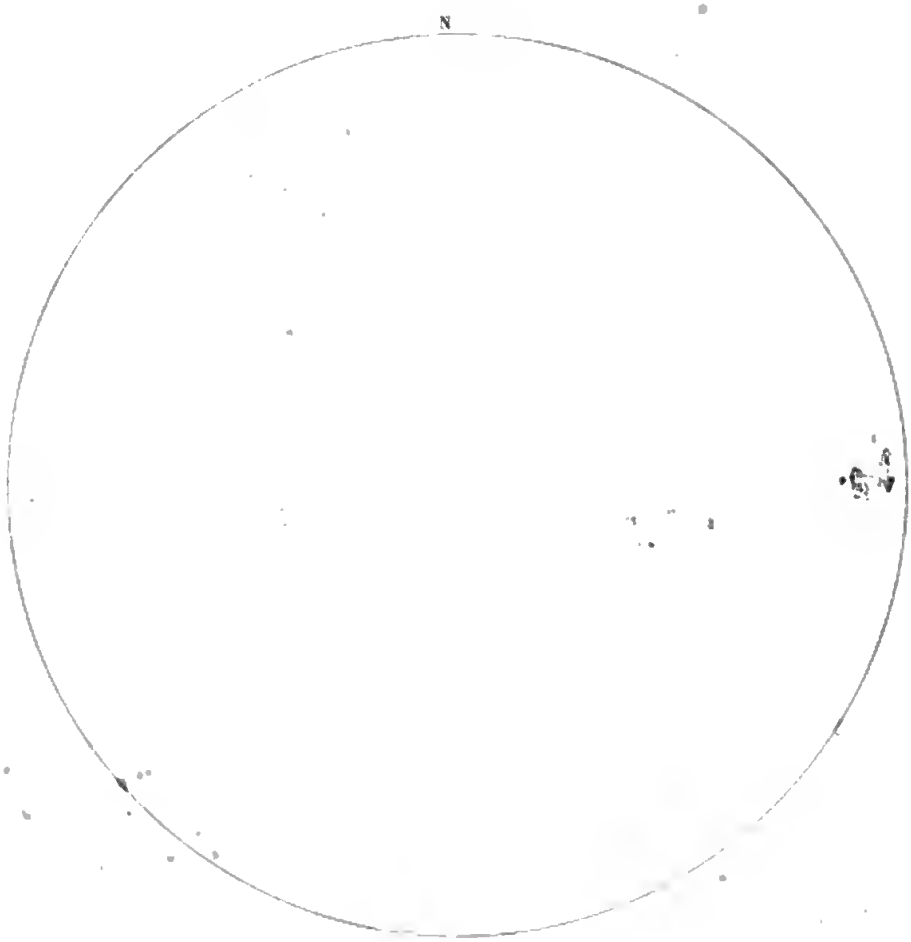

Nov. 4th

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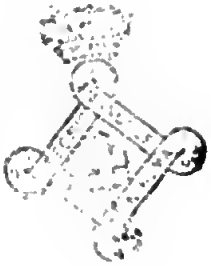

Digitized by Google

Series of the changes of a cluster

from the 20th of Sept. to the 1st of October

Series of the changes of another cluster

from the 11th to the 23d of October

Series of the changes of a third cluster

from the 28th of October to the 4th of November

Digitized by Google

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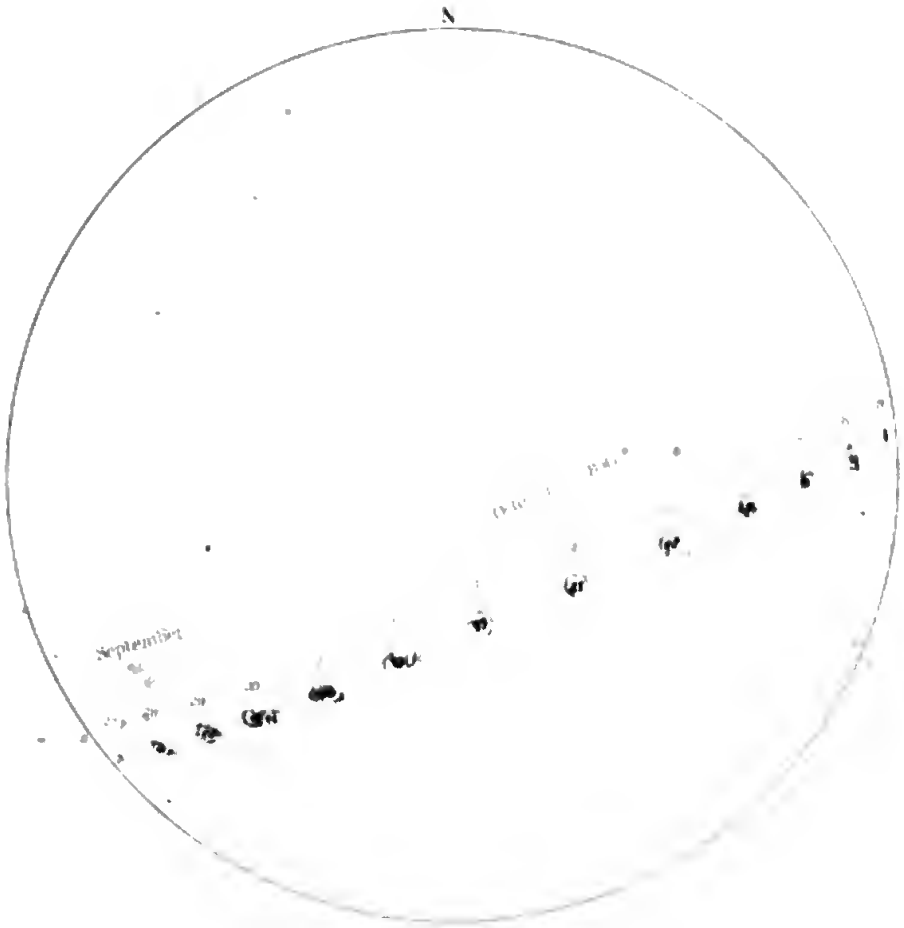
Diagram showing the track of a spot on the solar disk Plate XIV



MAG 200 55

VITTORIO EMANUELE
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